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POPULATION AND DEMOGRAPHY
Report No. 24

Vital Rates in India, 1961-1981

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Panel on India
Committee on Population and
Demography
Commission on Behavioral and
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PREFACE

The Committee on Population and Demography was established in April 1977 by the National Research Council in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, about the existence and extent of recent changes in fertility, and about the factors determining reductions in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women, or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Commission on Behavioral and Social Sciences and Education of the National Research Council. It was funded for a period of five and one-half years by AID under Contract No. AID/pha-C-1161 and Grant No. AID/DSPE-G-0061. Chaired by Ansley J. Coale, the committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);

3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

By 1982, 168 population specialists, including 94 from developing countries, had been involved in the work of the committee as members of panels or working groups. The committee, the commission, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

The committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Estimates of levels and recent trends judged to be the best that are feasible with available resources are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The third task of the committee, evaluation of factors determining birth rates, is the most difficult. Research on the determinants of fertility change has been carried out by scholars from several disciplines, and there is no comprehensive accepted theory of fertility change to guide the evaluation. Because of this state of knowledge of the causes of reductions in fertility and the difficulty of the task, the committee and the Commission on Behavioral and Social Sciences and Education established the separately funded Panel on Fertility Determinants, which includes scholars from anthropology, demography, economics, epidemiology, psychology, sociology, and statistics. Three committee members serve on the panel.

This report, on levels and recent trends of fertility and mortality in India is Report No. 24 in a series of reports issued by the Committee on Population and Demography. It is the result of work by the Panel on India, created by the committee and the Commission on Behavioral and Social Sciences and Education in 1978. The panel met twice and then sponsored a workshop in New Delhi at which several papers were presented and discussed. P. Padmanaba, Registrar General and Census Commission, India, and a panel member, assisted greatly with the organization of this workshop. In addition to panel members, the workshop participants included the committee chair, Ansley J. Coale, and several scholars and officials from various states of India.

Drawing upon the papers prepared for the workshop and more recent materials including available data from the 1981 census of India, this report was written by P. N. Mari Bhat, Samuel H. Preston, and Timothy Dyson. It would not have been possible without the abundant cooperation of the Office of the Registrar General of India. The Registrar General suplied published and unpublished tabulations on request and commented extensively on work commissioned by the panel. Hania Zlotnik provided staff support for the panel for 1978-81. Robert J. Lapham provided staff support after that and prepared the Summary.

In addition to financial support from AID, the preparation of this report was supported financially by general-purpose grants to the Univeristy of Pennsylvania from the William and Flora Hewlett Foundation and from the National Institute of Child Health and Human Development. The foundation also supported the printing costs through a grant to the National Academy of Sciences for that purpose.

Several individuals assisted with the many report production details. Shobhana Sheth ably typed the many tables and oft-revised text at the University of Pennsylvania. Solveig Padilla and Irene Martinez prepared the camera-ready text and tables at the Academy. Chris McShane edited the report, and Elaine McGarraugh added this report to her growing list of production-editing accomplishments. Susan Lapham drew the map of India and several figures. The committee extends its gratitude to these individuals and institutions for their contributions to the project.

Ansley J. Coale, Chair
Committee on Population and Demography

SUMMARY

India's sheer size--nearly 700 million people were counted in the 1981 census--ensures that developments in India will weigh heavily in any worldwide demographic accounting. Adding interest to demographic developments in India is its position as the first developing nation to endorse family planning programs officially and the variety of forms that birth control programs have taken there. A map of India is on page 14.

Although care must be taken not to accept Indian demographic information at face value, reasonably reliable and robust estimates can be constructed from the available sources. India has a long history of census-taking going back to 1881, although analysis of the data is hindered by poor quality, incomplete national coverage, and irregular tabulation categories; there are also problems of underenumeration and age misreporting. India's civil registration system, which goes back to the 1860s, is plagued by both underregistration and incomplete coverage, making the analysis of trends from these data almost impossible. As an alternative, the Sample Registration System (SRS) was initiated in 1964-65. This is a dual-record system with the main objective of providing reliable estimates of birth and death rates at the national and subnational levels. The SRS, while incomplete and somewhat uneven, provides valuable information on vital rates in India. However, it should be noted that in two states (Bihar and West Bengal), the completeness of sample registration is substantially below the all-India average; these states reported 106 million people in the 1971 census, 19 percent of India's total. In conjunction with the SRS, two surveys have been conducted: (1) a 1972 fertility survey covering 25 percent of the SRS sample areas, which yielded significant

data used in this report to arrive at fertility and mortality estimates and (2) a 1979 survey on infant and child mortality. Finally, the National Sample Surveys (NSS), an ongoing series of socioeconomic surveys conducted on a regular basis since 1953-54, have provided valuable data on children ever born and surviving from which indirect estimates of child and infant mortality could be derived; however, these surveys have been pushed into the background by the SRS, and SRS-NSS comparative studies indicate that the NSS data are affected considerably by the omission of events due to recall lapses and the heavy workload of NSS investigators.

This report draws on the data sources described above to provide estimates both for all-India and for the 15 Indian states with populations larger than 5 million in 1971. Just before this publication went to press, an age distribution from a 5-percent sample of the 1981 census became available for both sexes combined. This age distribution was considered to be too important to ignore, and estimates presented in this volume have been reinterpreted in light of the distribution, which proved to be particularly significant in the concluding chapter.

ALL-INDIA ESTIMATES

Mortality

A major conclusion of the mortality analysis is that a large decline in child mortality, heretofore undocumented, occurred in India during the 1960s. It is estimated that the probability of dying before age 2 declined from .225 about 1961 to .164 about 1968 (the 1968 figure is derived from a 1972 survey). Subsequent data sources suggest that more modest declines in child mortality occurred in the 1970s, although there is inconsistency between sources.

For analyzing adult mortality and crude death rates, the principal source of information is the SRS. The major quality checks available are tests of consistency with observed age distributions and growth rates. These tests suggest that SRS counts of adult deaths are about 10-percent deficient, although a wide range of estimates results from relatively small modifications in the tests. Male deaths appear to be somewhat more completely registered in the SRS than female deaths, and for this report the panel adopted figures of .93 for registration completeness of males and .87 for that of females. Because it is unlikely that mortality of children is more completely registered than that of adults, the figure of 10-percent underregistration is also used to correct crude death rates. However, the recorded SRS death rates below age 5 are subject to an offsetting bias--age overstatement--that might deprive the age group 0-4 of its lowest-mortality segment. Survey data confirmed the general levels of under-5 mortality recorded in the SRS in the early years of operation and suggest that SRS child mortality levels may be too high by the end of the 1970s. A simulation presented in the final chapter supports the survey results as does (indirectly) the 1971-81 intercensal analysis in Chapter 3. It is likely that a sizable mortality improvement occurred in 1979 because SRS crude death rates declined by 13 percent between 1977 and 1979 and declined again between 1979 and 1980. In general, the estimates presented here are less pessimistic than the conventional depiction of ponderous mortality change in India. The crude death rate for all-India declined from 18.8 in the period 1961-71 to 15.5 in 1971-76, and it continued down to 13.4 in 1976-81.

Fertility

The analysis of fertility is based on the 1972 and 1979 surveys and on SRS data. This analysis is complex because of data inadequacies that could be resolved satisfactorily only at the state level. In particular, marital distributions in the 1972 Fertility Survey are out of line with those in the 1971 census. If appropriate corrections are made, and if reported births in the past year are compared with lifetime births reported in the 1972 survey for each state, the result is a corrected total fertility rate for all-India of 5.60 in 1971-72 and a crude birth rate for the same period of 39.3 per 1,000. These figures, accepted as the most reliable estimates of fertility for the period, imply that SRS births are underregistered by about 7.8 percent for the 1970-73 period. Birth-last-year reports in the 1979 survey are judged to be 6-percent deficient relative to those in the 1972 survey. Our correction of these two surveys is smaller than those of other analysts, and implies that the decline in fertility has been faster than generally believed. This assessment is consistent with--but not wholly independent of--a large drop in the proportion of the population below age 10 between the censuses of 1971 and 1981.

Estimates of Vital Rates for 1961-71

The major method available for estimating vital rates in India before the advent of the SRS or the 1972 and 1979 surveys is intercensal survival analysis. Such analysis of the 1961-71 intercensal period is the principal subject of Chapter 3; a brief intercensal analysis of the 1971-81 period is included based on the 1981 age distribution. While intercensal analyses for 1961-71 have been performed by many others, this report introduces more solidly based information on child mortality than has been used previously. The estimated vital rates for 1961-71 (estimated through mean, forward, and backward survival techniques) are 41.0 for the crude birth rate, 18.8 for the crude death rate, and 5.72 for the total fertility rate (estimated indirectly by using the age pattern of fertility from the 1972 Fertility Survey). Life expectancy at birth is estimated at 46.8 for males and 45.2 for females; life expectancy at age 5 is estimated to be 55.4 for males and 53.7 for females. A comparison of 1961 and 1971 censuses by cohorts, together with an early life table computed from the SRS, suggests that the sex ratio of the 1971 census may have been depressed relative to 1961 by the selective omission of females in 1971.

Summary of All-India Vital Rates

Before the above estimates of fertility and mortality were accepted as final, the data were subjected to two additional tests. The first is a comparison of estimates for the 1971-81 decade against recorded 1971-81 intercensal growth. The crude birth rate for this decade from the SRS (corrected for 7.8-percent underregistration) is 37.4; the SRS crude death rate for the 1971-80 period (corrected for 10-percent underregistration) is 16.3. The implied crude rate of natural increase for the decade is 21.1 per 1,000, compared to the recorded intercensal growth rate of 22.2 between 1971 and 1981. It is believed, however, that the intercensal growth rate might be overstated by perhaps 0.4 per 1,000 by the differential omission of females from the 1971 census, reducing the intercensal growth rate to 21.8 per 1,000 and its difference from estimated natural increase to 0.7 per 1,000.

The second test, which is more complex, involves estimating the true age distribution of India in 1966 and projecting that age distribution forward to 1981 by age-specific rates of birth and death estimated for various 5-year periods. Two projections were made, using differing levels of mortality because of the inconsistency between survey and sample registration estimates of mortality. Comparison of results to 1971-81 intercensal growth supported the low-mortality scenario.

This second test was deemed more decisive because it uses more information both on the population of India and on formal demographic relationships. Furthermore, it produces an age distribution that, in its basic features, is validated by the 1981 census. It suggests that SRS birth and, especially, death rates need less upward correction to be nationally representative than is implied in the above paragraph. SRS "completeness" seems to improve as the decade progresses, which may reflect deficiencies (increasingly incomplete population base, increasingly unrepresentative areas) as well as virtues.

Combining these pieces of information, the panel offers the following summary of vital rates in India since 1961:

	1961-71	1971-81	1971-76	1976-81
Crude birth rate	41.0	35.9	37.9	34.0
Crude death rate	18.8	14.4	15.5	13.4
Total fertility rate	5.72		5.37	4.69
Life expectancy at birth, females	45.2		49.7	53.1
Life expectancy at birth, males	46.8		51.7	53.7
Probability of dying before age 2	.184		.151	.139

Note: The periods begin with March 1 of the initial year.

Age-specific fertility rates corresponding to these estimates are presented in Chapter 4.

The general picture is one of persistent change. The gain in life expectancy at birth is 7.4 years during a 12-year period, which is a very respectable pace by international standards. However, inconsistency between sources suggests that less confidence should be placed in this conclusion than would otherwise be the case. The sizable decline is supported by child mortality surveys and by intercensal growth, but not by SRS annual rates. A decline in fertility appears to accelerate somewhat during the 1970s, more so for total fertility than for the crude birth rate. The decline in the total fertility rate amounts to slightly more than one child per woman in a period of 12.5 years (1966-78). Thus, the panel estimates that fertility had declined more than is generally believed. The slower change in the crude birth rate probably reflects two factors: an increase in the proportion of females who are of childbearing age, induced by the fertility decline itself; and larger changes in age-specific fertility at higher ages, which receive more weight in calculations of total fertility than of the crude birth rate.

On a regional level, in general, higher mortality and fertility conditions are persistently found in the north than in the south of India; however, there is, perhaps surprisingly, little regional differentiation in recent changes in vital rates. The following section addresses state-specific results, which are the focus for the majority of this report.

STATE ESTIMATES

Mortality

Final estimates of the probability of dying by exact age 2 during the 1960s are shown in the 3 panels of Figure 1 for 15 major states in India. Each panel represents a range of mid-decade estimates; the left panel from .180 in Tamil Nadu to .262 in Uttar Pradesh; the middle panel from .153 in Maharashtra to .166 in Gujarat; and the right panel from .099 in Kerala to .141 in West Bengal. Note the considerable variation among states: during the 1960s, about 9 in 10 children in Kerela survived to the age of 2, while in Uttar Pradesh, only 3 out of 4 survived to this age. Punjab and West Bengal are among the

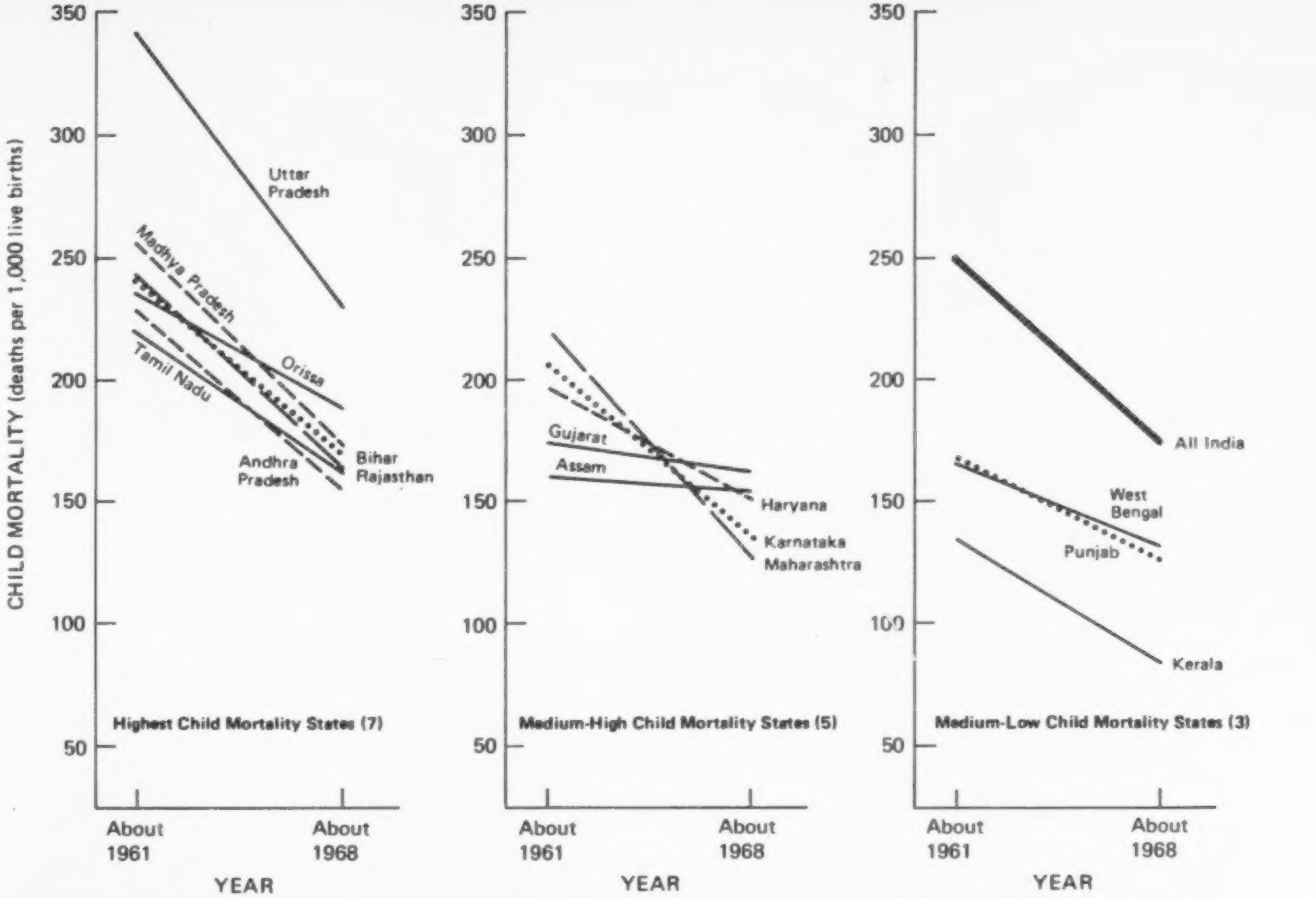


FIGURE 1 Child Mortality: Final Estimates of the Probability of Dying by Exact Age 2, About 1961 and 1968 in 15 States and All-India
Source: Table 17, p. 68.

comparatively lower-mortality states, while Orissa, Madhya Pradesh, Bihar, and Rajasthan are among the higher-mortality states. Figure 1 shows that 13 of these 15 states had substantial declines in the probability of dying by exact age 2 during the 1960s.

Crude death rates are also estimated for the 15 large states for the 1960s and the 1970s. Because infant and child mortality comprise a major part of overall mortality, the pattern for crude death rates among states is similar but not identical to that for child mortality. Figure 2 presents the results in 3 panels, classified by the crude death rate estimate for 1978. The left panel includes 4 states with a range from about 17 to above 20; the middle panel shows 6 states with a 1978 range from about 14 to 16; the right panel shows 4 states with a range of 12 or 13, plus Kerala, which had a crude death rate of about 8 in 1978. The trends in the crude death rates in Figure 2 are based on two major sources of estimates: intercensal analysis for the 1961-71 decade, and death rates produced by the SRS since 1970, corrected for estimated underregistration. For the latter, the completeness is estimated to be .9 throughout the decade and in each state, although there is some suggestion for all-India that completeness may have improved.

The two basic procedures used produce a picture of smoothly declining crude death rates for all-India. Uttar Pradesh, Madhya Pradesh, Bihar, and Orissa are the highest-mortality states in the 1961-71 period, just as they are at the end of the 1970s; Kerala and Punjab have the lowest-mortality rates in all series. Thus there is a north/south gradient in mortality; this is also true for fertility, discussed below, but with some major differences. Orissa in East India, intermediate in fertility levels, clearly belongs with the high-mortality northern groups; Haryana, in the high-fertility northern group, is closer to neighboring Punjab in its low crude death rate.

There is relatively little regional differentiation in death rate trends. The three states with the largest declines in crude death rates in Figure 2, Andhra Pradesh, Uttar Pradesh, and Karnataka, are three of the five states that had an acceleration in intercensal growth between 1961-71 and 1971-81. This correspondence not only helps to confirm the validity of estimated trends in crude death rates but also suggests the important role of changing death rates in accounting for changing patterns of regional growth.

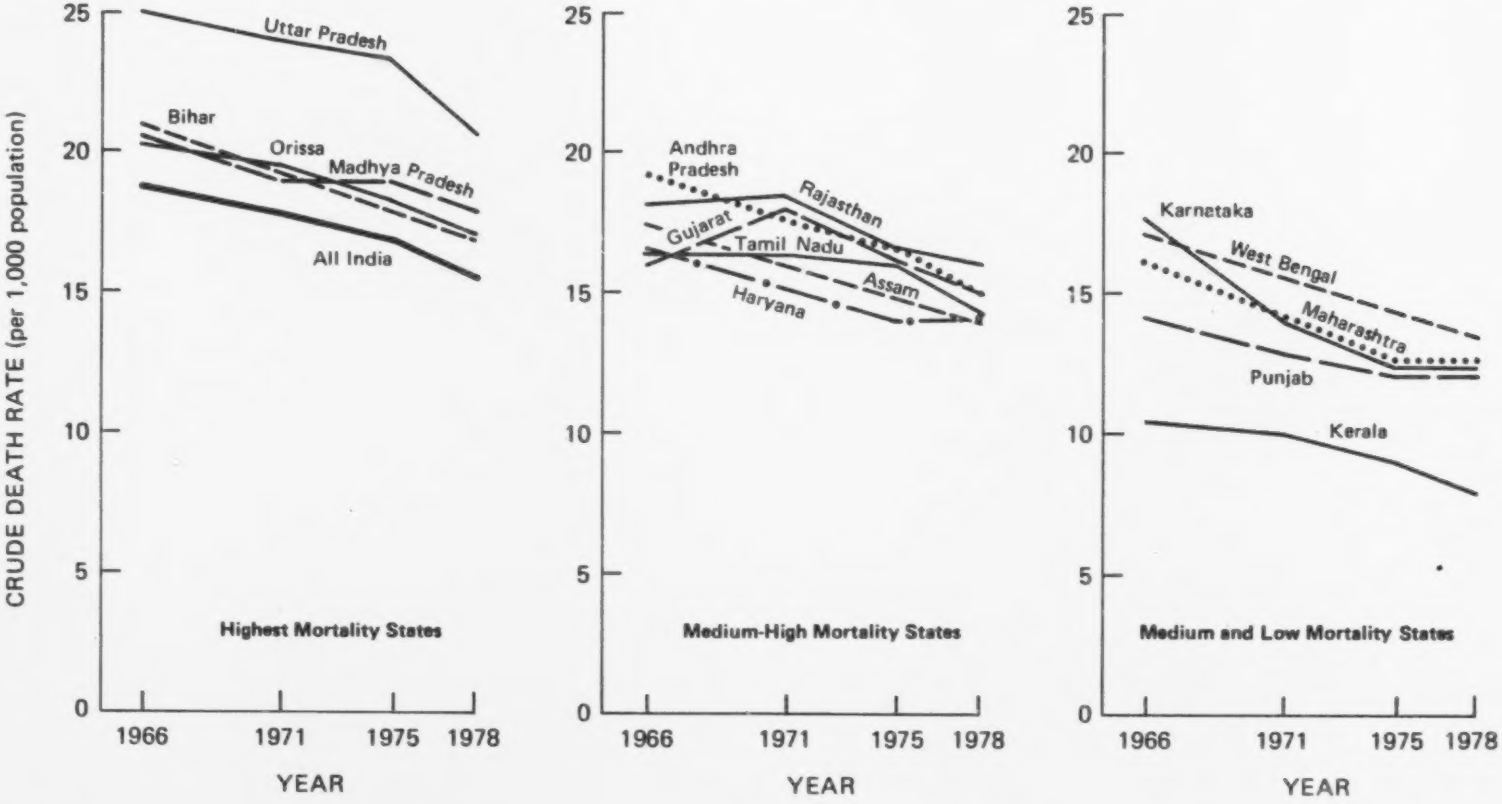


FIGURE 2 Crude Death Rate Trends Between 1968 and 1978 in 15 States and All-India
Source: Table 42, p. 134.

Fertility

Fertility, as measured by the crude birth rate, also varies considerably among states in India: whereas the estimated crude birth rate in 1979 is 40 in Uttar Pradesh, Haryana, and Madhya Pradesh, it is just over 30 in Punjab and Maharashtra, and 28 in Kerala. Figure 3 presents a summary of crude birth rate estimates for approximately 1968 and 1978 for the 15 states of India with populations of 5 million or more. These estimates reflect an extremely wide variety of procedures, and therefore what appear to be trends may simply reflect the differential impact of error, widespread in India, on the results of various techniques. The estimates in Figure 3 are based on the averages of five series presented in Table 39 of the full report, three for the 1960s and early 1970s, and two for 1976 and 1979.

In this regard, it is reassuring to note that there is a very high correlation among the various series. States in northern India--Rajasthan, Haryana, Uttar Pradesh, Assam, and Madhya Pradesh--have birth rates above the mean in each of the five series. The southernmost states--Kerala, Tamil Nadu, Karnataka, Maharashtra, and Andhra Pradesh--are below the means in each of the five series. Bihar resembles the northern group in the three series in which it reliably appears; Gujarat also leans in the northerly direction. Orissa and West Bengal, forming a contiguous area in East India, show no persistent deviation from the all-India averages. Only Punjab violates the north/south dichotomy, being a below-average state in each of the five series by about 4-5 per 1,000. The regional picture also appears remarkably clear in view of the extraordinary diversity of procedures and data used: census age distributions combined with survey estimates of child mortality; fertility survey questions on births in the previous year-end parity; age distributions of population and deaths by age in the SRS; and SRS births corrected by estimates of underregistration.

State birth rate trends are also subject to method-specific error, particularly since the latest two estimates are based on the weakest information (the 1979 estimate using correction factors estimated for 1971-72, while all-India results suggest that the factors should have declined). Nevertheless, a clear impression emerges from Figure 3 that all regions have shared roughly equally in the birth rate decline, although they started from

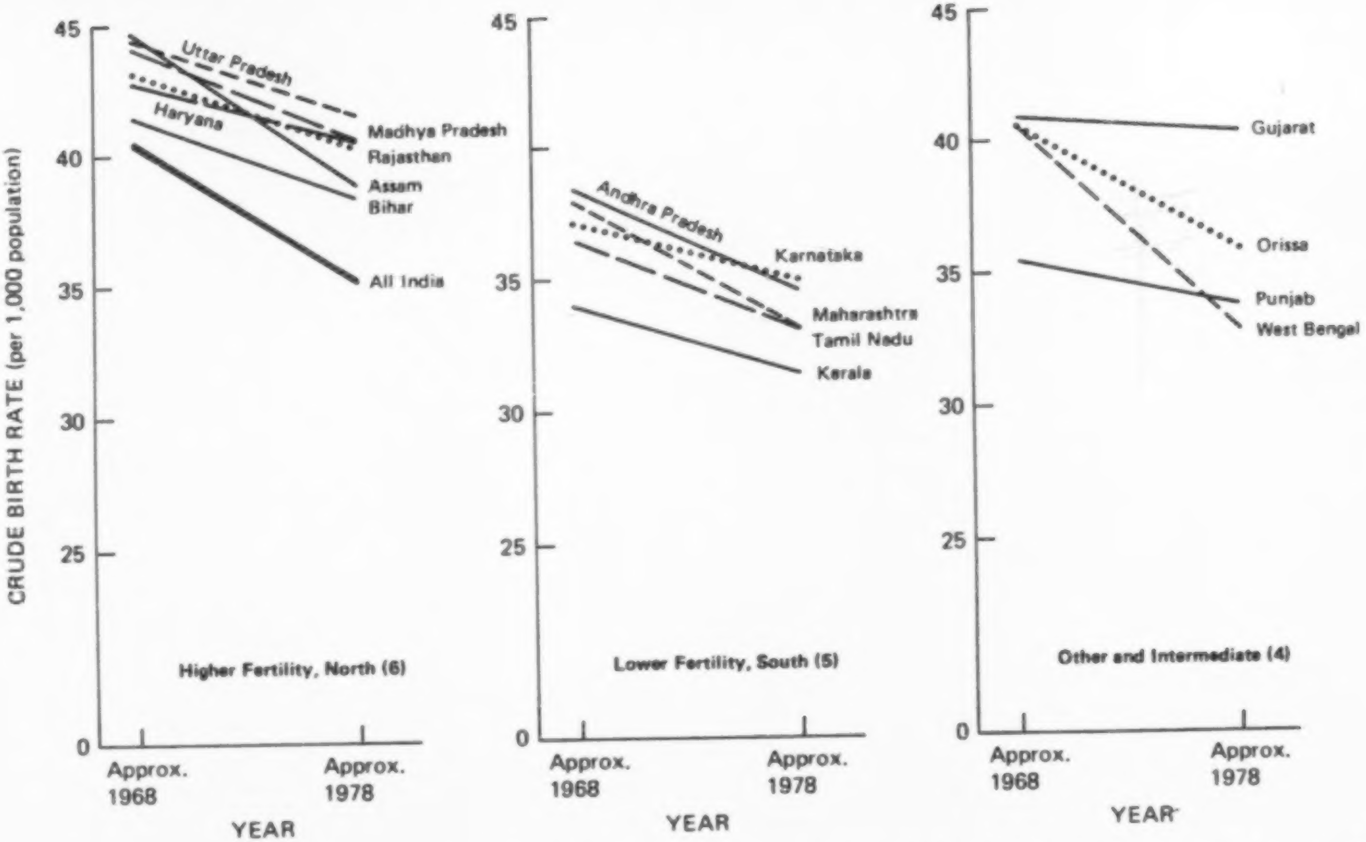


FIGURE 3 Crude Birth Rate Trends Between Approximately 1968 and 1978 in 15 States and All-India
Source: Table 39, p. 129.

different levels. This impression is confirmed in the following summary of changes in the mean crude birth rates in groups of states between approximately 1968 and 1978:

	Mean Crude Birth Rate 1961-71, 1966-71, 1971-72	Mean Crude Birth Rate, 1975-76, 1979	Approximate Decadal Decline
High Fertility, North (6)			
Assam, Bihar, Haryana, Madhya Pradesh, Rajasthan, Uttar Pradesh	43.66	39.97	3.69
Low Fertility, South (5)			
Andhra Pradesh, Karnataka, Kerala, Maharashtra, Tamil Nadu	38.83	33.45	3.38
Other and Intermediate (4)			
Gujarat, Orissa, Punjab, West Bengal	39.39	35.64	3.75

Source: Table 39, page 129.

There is no substantial difference in the pace of decline among the northern, southern, and intermediate groups of states. Of course, there is no assurance that the same factors underlie the trends in various regions. For example, a larger fraction of the decline in the north may be attributable to that region's larger decline in child mortality and associated age distributional disturbances. It is also possible that SRS completeness deteriorated during the 1970s in the north relative to other regions; a state-specific analysis of intercensal growth 1971-81 indicates that, in Rajasthan and Uttar Pradesh, growth did not decelerate as much as is implied by SRS figures.

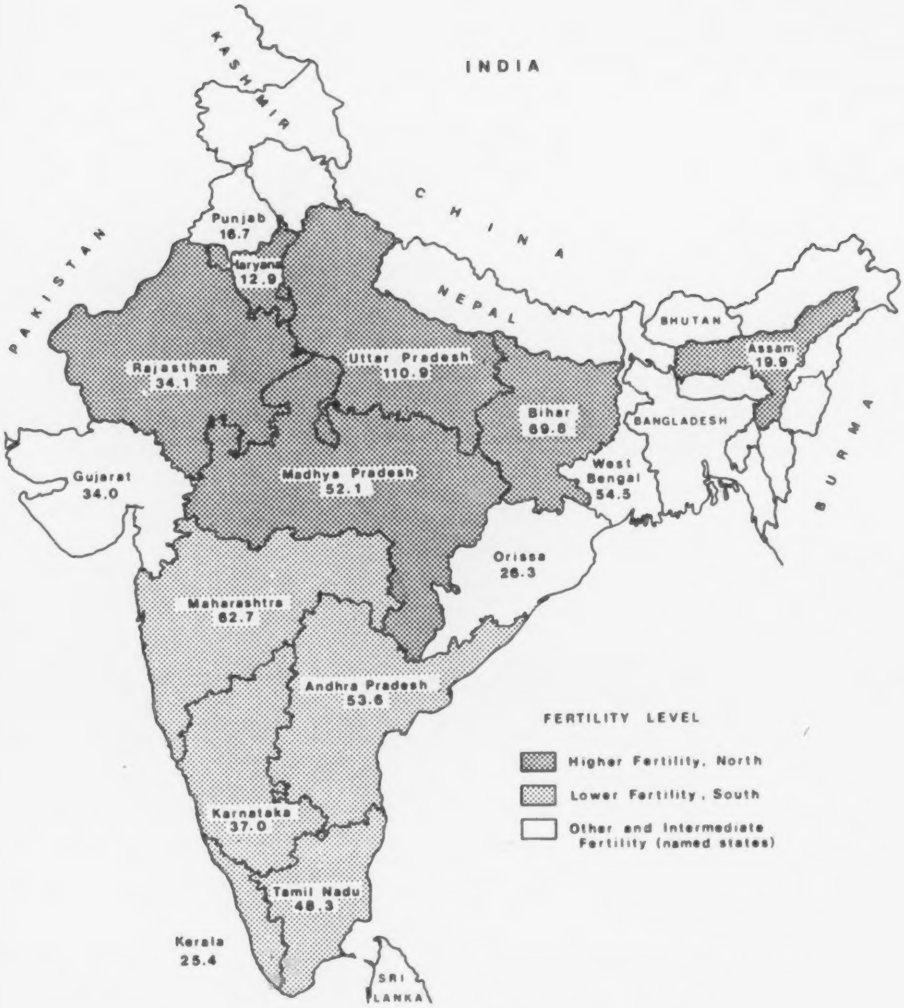
While this report also examines total fertility rates (TFR), the estimates are less reliable than crude birth rate estimates because they require information on the age pattern of fertility as well as on its volume. Age reporting in India is not accurate by international standards; in addition, we had only one source of information about the age pattern of fertility by state--the 1972 Fertility Survey. Because of these problems and on the basis of analysis of the TFR estimates by state, the panel concludes that the crude birth rate estimates are substantially more solid because of the multiplicity of sources and methods available for estimating them.

The last-minute availability of state age distributions (both sexes combined) permitted a reexamination of these conclusions in Chapter 4. This analysis confirmed the continuation of a sizable North/South differential in birth rates. It also confirmed the absence of strong regional differentiation in fertility decline. However, it suggested that, just as for all-India, birth rates by state have declined by more than implied by SRS trends during the 1970s.

CONCLUSION

Performing research on the demography of India can be a humbling experience. Pitfalls in Indian data are sometimes obvious and sometimes hidden, and demographic scenarios can be very different depending on how one chooses to correct them. We are impressed by the degree to which demographic analyses in India must be a continuous activity of updating and integrating estimates. We will doubtless have a better picture of the demography of the 1971-81 period in 5 years than we have now, and the temptation is to withhold estimates until they are as well justified as possible. But by then their utility is much reduced. We offer these estimates not as the final word but as the best we can do at present. We are fully aware that a reasonable case could be made for raising recent birth and death rates by several points and that such a case might be validated sometime in the 1980s by a survey finding higher child mortality.

To the extent that we have been able to reduce the range of uncertainty about Indian demography, our success is largely a product of the availability of overlapping sources of information. While the SRS is performing a valuable service in mapping yearly trends in crude birth and death rates, its products would have far less value if they could not be tested periodically against other information. Particularly important in this regard are surveys asking questions on lifetime births and child deaths. It is not sufficient simply to ask about these matters; the manner in which questions are asked and the data processed are critical determinants of the quality of the results, as illustrated by the comparative quality of the 1972 and 1979 surveys. Furthermore, providing the foundation for all attempts to understand the demography of India are the series of decennial censuses, mounted at great cost in a country in which competition for resources is intense. Even though much of the 1981 census remains to be published, several pieces of evidence derived from it have been a critical factor in establishing the set of estimates presented in this report.


INDIA
KASHMIR
CHINA
NEPAL
PAKISTAN
BHUTAN
BANGLADESH
BURMA
SRI LANKA
Punjab 16.7
Haryana 12.9
Rajasthan 34.1
Uttar Pradesh 110.9
Bihar 69.8
Assam 19.9
West Bengal 54.5
Gujarat 34.0
Madhya Pradesh 52.1
Orissa 26.3
Maharashtra 62.7
Andhra Pradesh 53.6
Karnataka 37.0
Tamil Nadu 48.3
Kerala 25.4
FERTILITY LEVEL
Higher Fertility, North
Lower Fertility, South
Other and Intermediate Fertility (named states)

Map of India, with 15 Large States Identified by Population Size (in millions) and Fertility Level

Source of population data: 1981 Census of India, as reported in Census of India, Series 1, Paper 3 of 1981, Provisional Population Totals: Workers and Non-Workers. New Delhi 1983: Registrar General and Census Commissioner for India. For Assam, a projected population estimate is used, since a census was not taken there in 1981.

1 INTRODUCTION

There is no need to stress the importance of India for an understanding of international population trends. Its sheer size--nearly 700 million people were counted in the 1981 census--ensures that developments in India weigh heavily in any worldwide demographic accounting. Its population is about equal in size to that of South America and Africa combined. Were it a separate nation, Uttar Pradesh would rank among the world's 10 largest countries. Adding interest to demographic developments in India is its position as the first developing nation to endorse family planning programs officially, in addition to the variety of forms that birth control programs have taken there.

Because of India's size and regional diversity, the Panel on India elected to make estimates not only for all-India but also for the 15 states with populations larger than 5 million in 1971 (see map). This decision proved to be costly in time, effort, and elegance. But ultimately the regional focus shed light on this neglected feature of Indian demography and improved national estimates by allowing corrections and adjustments to be made on a state-by-state basis. It also permitted examination of the regional consistency of results from different sources and procedures, thereby helping to test the validity of results at the national level.

Any appraisal of India's demographic circumstances should begin with a discussion of the data sources on which the appraisal is based. For a country at its level of economic development, India is unusually well situated with regard to demographic data. One advantage is its long history of census taking. But only in the last 15 years, with the development of the Sample Registration System and the conduct of several sample surveys, have the data become rich and diverse enough to form a solid basis for estimating vital rates. In this chapter, we review several features of Indian data that are pertinent to the panel's work, with special emphasis on studies of data quality.

1.1 POPULATION CENSUSES

Since the first synchronous census in 1881, the population of India has been counted once every 10 years. This series of decennial censuses is perhaps the single most important source of demographic data in India. In the absence of a reliable civil registration system, the information on the growth and the age-sex structure of the population provided by the census formed for a long period the sole basis of estimation of fertility and mortality. Although some specific questions on fertility and mortality have been asked on a sample basis for certain states in every census since 1911, analysis of the data is hindered by poor quality, incomplete national coverage, and irregular tabulation categories.

The total populations and sex ratios recorded in recent censuses for the current territory of India are shown below:

Year	Population (1,000s)	Sex Ratio (males per 100 females)
1941	318,661	105.8
1951	361,088	105.7
1961	439,235	106.3
1971	548,160	107.5
1981	685,185	106.9*

*Excludes Assam.

Source: India, Registrar General (1975a, 1983b).

The Post Enumeration Check (PEC) surveys indicate that the total counts of the population returned in Indian censuses are quite accurate. The first verification of the census count was carried out after the 1951 census. It showed a net undercount of 1.1 percent (India, Registrar General, 1953). Similar surveys conducted after the 1961 and 1971 censuses revealed a net undercount of the order of 1-2 percent (India, Registrar General, 1964a, 1975a). However, doubts have been raised about the reliability of these figures, since the PEC surveys suffer from some of the same drawbacks as the population censuses that they attempt to evaluate. Some independent indirect estimates place the level of underenumeration in Indian censuses at higher levels (Coale and Hoover, 1958; Dandekar and Mulay, 1975; Bureau of the Census, 1978; Operations Research Group, 1974).

In estimating the trends and levels of fertility and mortality from census data, the actual level of underenumeration is not as crucial as the relative levels of underenumeration in two consecutive censuses. We present below some evidence that the level of female underenumeration was greater in the 1971 census of India than in the 1961 census. There is reason to believe that the 1971 census may have been subject to greater error than previous censuses because it was upset by elections held in February and had to be postponed until April 1 (Visaria, 1971; Visaria and Visaria, 1981). Age differentials in completeness can also affect estimates of fertility and mortality. Although it has been long suspected that there is relatively more underenumeration of children than of adults in Indian censuses, good data on this subject have become available only for 1971, when results from the PEC survey were tabulated by age. As is clear from Table 1, estimated omission is greater among children than adults; the table also indicates that there is greater likelihood of female children being missed in the census than of male children. The implication of these results for demographic estimation is that the actual age distribution is probably younger than that of the enumerated population; for most census-based procedures, this bias produces an underestimate of fertility levels.

The results of the Post Enumeration Check of the 1981 census have recently been released (India, Registrar General, 1983a). They reveal an undercount of males of 1.710 percent and of females of 1.885 percent. Thus the female undercount figure is almost identical to that of 1971, while the male enumeration completeness is estimated to have deteriorated by about 0.10 percent. Of course, the implied deterioration may simply reflect improvements in the conduct or processing of the post-enumeration check itself.

TABLE 1 Estimated Net Omission Rate (per 1,000) by Age, Post-Enumeration Check Survey, 1971 Census: All-India

Age Interval	Male	Female
0	29.91	45.82
1-4	17.97	20.20
5-14	14.27	15.51
15-34	16.25	18.09
35-44	10.41	8.43
45-59	8.12	14.60
60+	7.72	23.49
All Ages	15.27	18.32

Source: India, Registrar General (1975a).

Another source of error in reported age distributions is age misreporting. Since age is not an important concept for most Indians, the recorded age distributions from Indian censuses suffer from considerable distortions. The ignorance of one's own true age results in a tendency to guess an age that ends in a common or desirable digit. A casual glance at a single year of age distribution from any of the Indian censuses shows that an unusually high proportion of the population report their ages as ending in digits 0 and 5. Digits 2 and 8 are also important centers of concentration, especially at younger ages. The patterns of digital preference are not the same at all stages of the life cycle. Among children, heaping is not too pronounced, probably because they were born recently and there is marked physiological development with age among children and adolescents. As age advances, guessing becomes more difficult and the concentration of the population reporting ages ending with digits 5 and especially 0 increases. The concentration at ages ending with digits 8 and 2 noticeably decreases after early adulthood (India, Registrar General, 1963). Analysis also shows that age heaping is more pronounced among the female population (India, Registrar General, 1963).

TABLE 2 Indices of Digital Preference in the Census: All-India

Indices	1951		1961		1971	
	Male	Female	Male	Female	Male	Female
Whipples Index (range 100 to 500)	247	258	282	294	302	308
Myers' Index (range 0 to 180)	61.4	57.4	75.1	70.7	64.8	68.1

Source: Zlotnik (1979).

In demographic and actuarial literature, two summary measures--Whipple's Index and Myers's Index--are often used to gauge the level of digital preference. Whipple's Index measures the relative preference for digits 0 and 5 in the age range 23-62. If there is no concentration, the index measure is 100, and if everyone reported his or her age only in multiples of 5, the index would be 500. The index proposed by Myers measures the preferences for each of the 10 digits 0-9, and an overall index is calculated by adding, irrespective of signs, 10 individual values. This index could vary from 0 to 180. Table 2 shows the values of both indices derived for the age distributions recorded in the 1951, 1961, and 1971 censuses (the 1981 age distribution had not been released to date). Whipple's Index shows that the concentration of the population reporting ages ending with digits 0 and 5 has increased steadily. The trend indicated by Myers's Index is less clear, but on the whole it seems that the age concentrations in the 1971 and 1961 census returns were greater than those in 1951.

In demographic estimation the effects of digital preference can sometimes be effectively handled by grouping individuals into appropriate age intervals. Systematic errors in age reporting--those that produce systematic over- or understatements of age--often pose considerably greater problems. The presence of systematic errors in age data can be demonstrated in several ways. A traditional method is to compute age and sex ratios. Figures 4 and 5 show age ratios and sex ratios by five-year age intervals computed from the age distributions returned in the last four censuses. The virtual constancy of the age pattern of these ratios and the fact that they do not shift in a cohort-specific way over the years, strongly suggest the existence of persistent and systematic errors in age reporting. Figure 4 indicates that there is a relative excess of persons in the age intervals 5-9, 25-29, 30-34, 40-44, and 50-54, compared with adjacent five-year intervals. The age pattern of sex ratios in Figure 5 indicates that there is a noticeable excess of males over females in the 10-14 age interval, often a relative deficit of males in the 20-24 age interval, and an excess of males in the age range 35-59. Similar results are revealed by intercensal comparisons of the size of cohorts (Ewbank, 1981) and by comparison of census age distributions to model stable or quasi-stable distributions (Coale and Demeny, 1967).

None of the methods for detecting systematic errors in age reporting can distinguish the errors caused by differential omission by age from those caused by misstatement of age. A unique opportunity for making this distinction for children is presented by the Census Evaluation Study (India, Registrar General, 1977c). The purpose of this study was to carry out an independent check of census returns by matching them with Sample Registration System records on births in the years preceding the census. The adjustment factors for each age derived from these data are shown in Table 3.

Adjustment factors greater than unity for omission confirm that a large number of children are not enumerated in the census. Contrary to results of the PEC survey, these data show that male children are more likely to be omitted than females. The adjustment factors for age misstatements indicate that a considerable number of zero- and one-year-olds were reported in higher ages in the census. The report on this study also mentions that about 6.1 percent of males and 4.2 percent of females ages 0-4 were enumerated in the 5-9 age interval in the census. If omissions in the 0-2 age interval are any indication of the extent of underenumeration in the 0-4 age interval, then the omission of children seems to be a more important reason than overreporting of age for the normally observed deficit in the 0-4 age group.

Some additional insights into the pattern of age misreporting in India can be obtained from a study by Dandekar (1966). She matched the age returns of the population of a small town in the 1951 and 1961 censuses

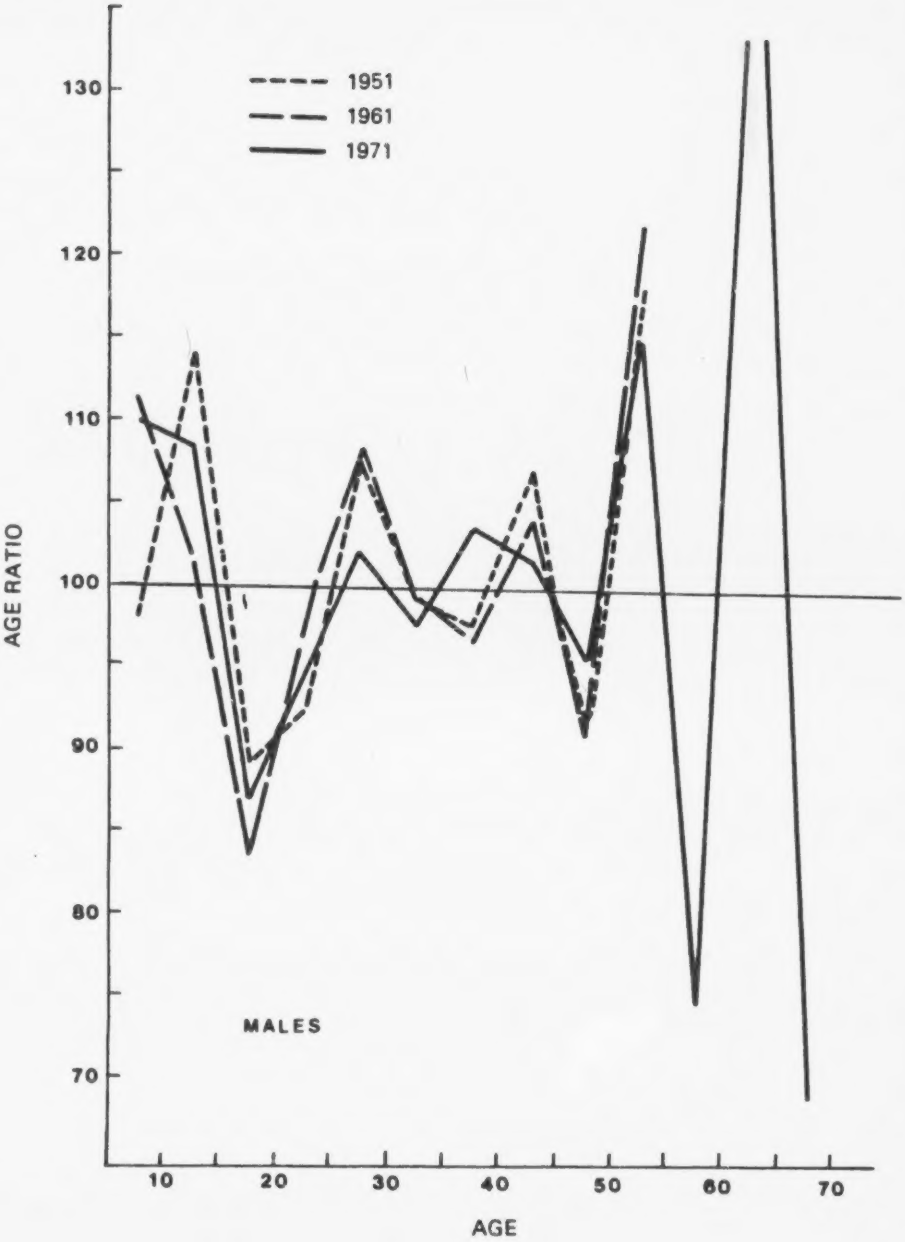
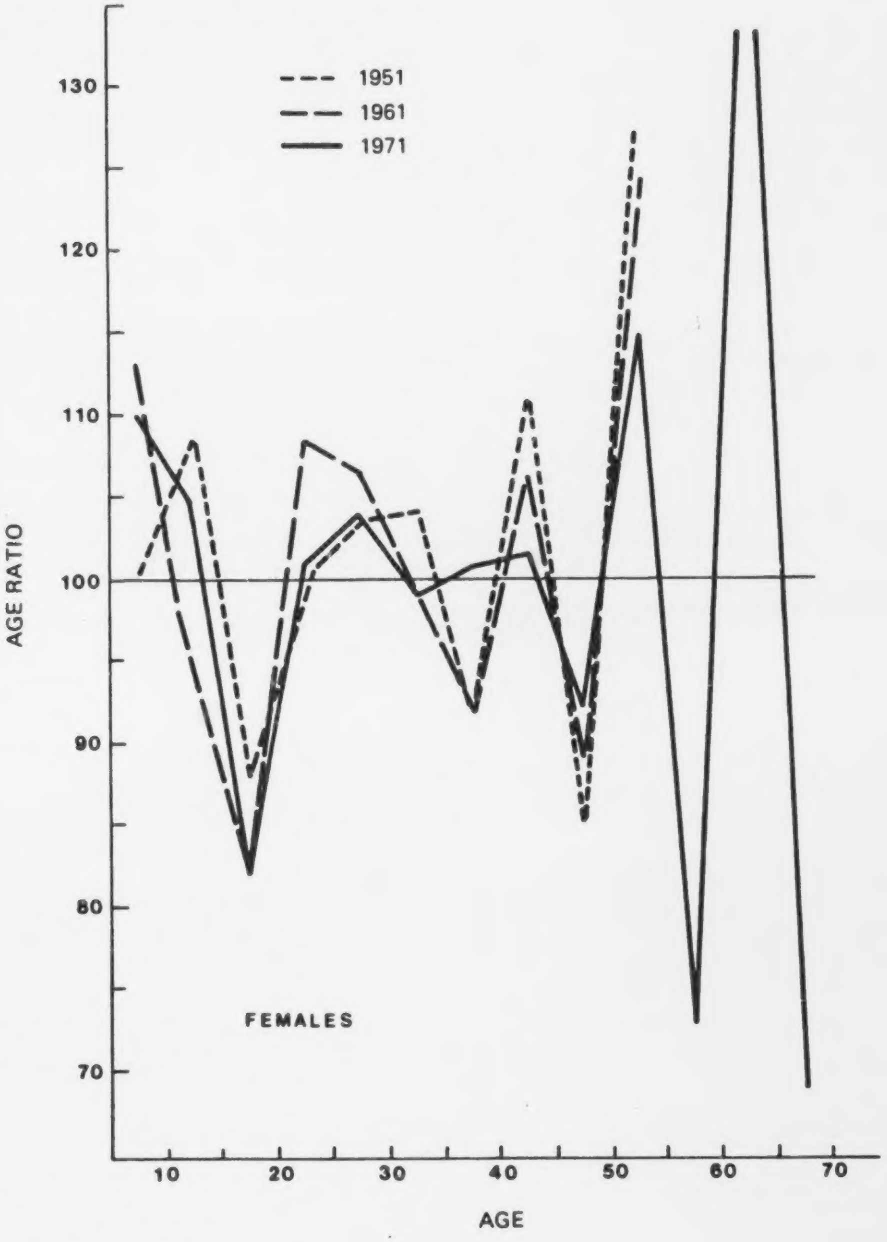


FIGURE 4 Age Ratios, Males and Females

FIGURE 4 (continued)



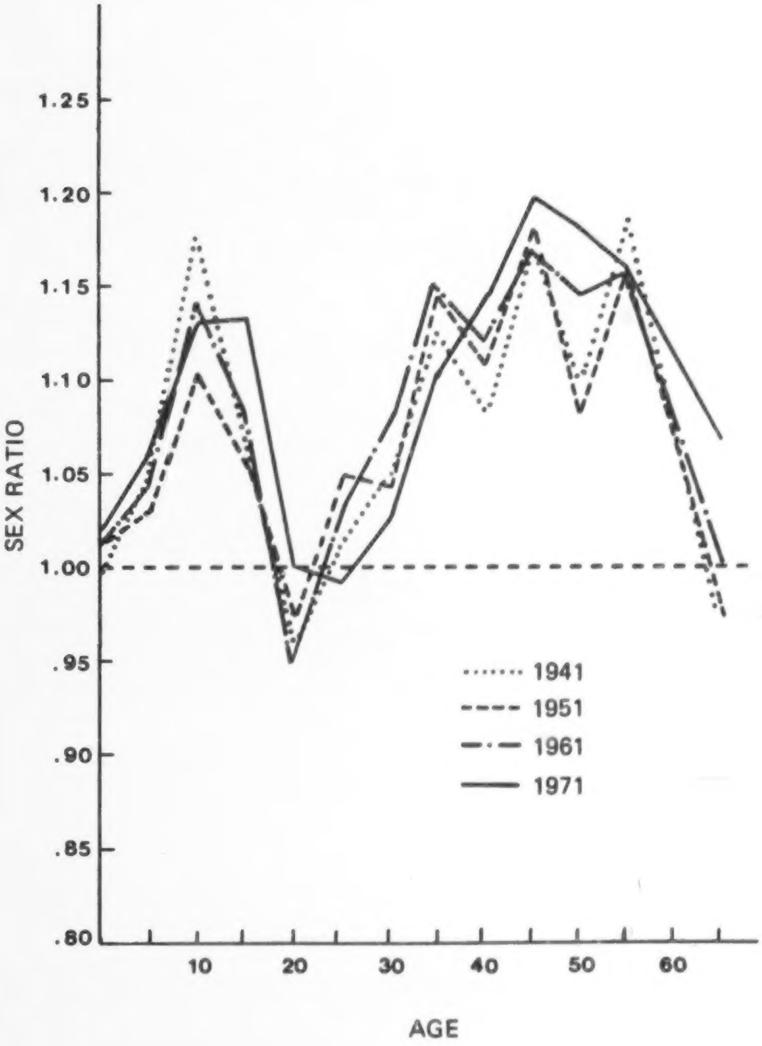


FIGURE 5 Sex Ratios for Different Censuses

(Table 4). A person's exact ages were not known for either of the census dates, only that the difference between them should be the 10 years between the censuses. Table 4 demonstrates that the proportion of persons aged x to x + 5 in 1951 who were also reported to be ages x + 10 to x + 15 in 1961 steadily declines as age advances, consistent with the hypothesis that guessing

TABLE 3 Adjustment Factors for Age Misstatement and Omission, Census Evaluation Study, 1971: All-India

Age Reported in the Census	Factors for Adjusting Age Misstatements		Factors for Adjusting Omissions	
	Male	Female	Male	Female
0	1.040	1.013	1.170	1.152
1	1.345	1.332	1.225	1.213
2	0.868	0.899	1.104	1.076

Source: India, Registrar General (1977c).

age becomes more difficult as a person becomes older. The table also shows that both overreporting and underreporting of age increase as age advances and that at any age interval the underreporting tendencies are stronger. This pattern would imply that, for both males and females, the proportion under any age would be overestimated in the recorded population, except possibly at age 30, around which the two opposing tendencies may cancel. This implication, however, does not conform with conclusions from stable population analysis, perhaps because of the differential omission of children in the census.

The results shown in Table 4 have some disturbing implications for the estimation of adult mortality from the forward projection method described by Coale and Demeny (1967). The ratios of population above age x in 1961 to the population above age x - 10 in 1951 were computed from the Dandekar study (see Table 5). Since we are dealing with age distributions of matched persons who survived from 1951 to 1961, the survival ratio should be unity. The deviations from unity of the computed ratios are therefore pure measures of age distortions. As Table 5 shows, the ratios are less than 1.0 with very few exceptions. The implication is that the forward projection method would tend to underestimate life expectancy levels. However, since Dandekar's study is based on a small sample of matched individuals, without further confirmation from other studies it is injudicious to generalize this conclusion to all-India.

TABLE 4 1951 and 1961 Census Age Returns Matched for a Small Town in Maharashtra: India

Reported Age in 1951 x to x+5	Number in 1951	Male			Number in 1951	Female		
		Percent Who Reported Age in 1961				Percent Who Reported Age in 1961		
		< x+10	x+10-x+15	>x+15		< x+10	x+10-x+15	>x+15
0-4	309	11	81	8	291	23	75	2
5-9	341	34	56	10	127	61	32	7
10-14	222	26	53	21	88	21	52	27
15-19	144	24	58	19	144	28	48	24
20-24	132	32	52	16	136	43	38	19
25-29	101	37	39	25	161	40	35	25
30-34	111	50	24	26	154	48	31	21
35-39	119	38	30	32	159	42	32	26
40-44	130	49	31	20	157	43	24	34
45-49	129	45	28	27	98	44	23	33
50+	243	12	88	--	159	8	92	--
Total	1,981				1,644			

Source: Computed from Dandekar (1966).

TABLE 5 Ratios of the Population of Cohorts Above Certain Initial Ages in Two Successive Censuses, Based on Intercensal Matching Study in Maharashtra: India

Age in Later Census	Male $\frac{C^{61}(x)}{C^{51}(x-10)}$	Female $\frac{C^{61}(x)}{C^{51}(x-10)}$
10	.983	.959
15	.943	.947
20	.983	.993
25	1.015	.988
30	.990	.950
35	.965	.923
40	.937	.917
45	.923	.897
50	.888	.918

Source: Table 4.

We have discussed the problem of using census age distributions in demographic estimation. Indian census authorities have also tried to collect direct information on fertility and mortality. Special inquiries on the fertility of couples began with the 1911 census when some information was collected on a voluntary basis in the Central Provinces and Berar. In 1921 the coverage was extended to five more provinces/states, and in 1931 the entire Indian Union was brought under the inquiry; however, the choice of persons to whom the questions were asked was left to the discretion of the enumerators. It is believed that they tended to ask these questions disproportionately of members of large families. A large number of turned-in slips had to be discarded because they were incomplete, duplicates, or unintelligible. It has been concluded therefore that these data are not helpful in the estimation of fertility levels (Ghosh, 1940; Das Gupta et al., 1955), yet the data on proportion of surviving children may not have been severely affected by these biases. Unfortunately, the required tabulations were not made, except for two provinces in 1921.

In 1941 the questions on fertility and mortality became compulsory and were not asked on a sample basis, as in earlier censuses. Due to the interruption of World War II, however, many provinces failed to tabulate these data. In 1951 special questions on fertility and mortality were asked in the states of Madhya Pradesh, Travancore-Cochin, and Bihar. The tabulated data from Bihar were never published. Some information on fertility and mortality collected during the training program for census enumerators in 1950 was published in the 1951 West Bengal census volume. The failure of the enumerators to separately record zero parity or parity not stated seems to have reduced the utility of 1951 census fertility data (El-Badry, 1961). In a 1961 census fertility inquiry, some valuable data on fertility and mortality were collected, but the tabulations were restricted because of financial and time constraints. In the 1971 census, the only information collected related to births in the last year, tabulated in wide and irregular age intervals. Since the quality of collected ferility data seemed to be very poor (e.g., Dyson, 1979b), no attempt was made to estimate fertility levels on the basis of these data.

1.2 CIVIL REGISTRATION

The history of registration in India dates back to the 1860s, when statistics on deaths began to be collected as a result of efforts of the Sanitary Commissioners of the government of India. Excellent accounts of the development of vital registration in India are available elsewhere (e.g., India, Director General of Health Services, 1959; India, Registrar General, 1972a) and need not be repeated here. What concerns us here is the completeness of vital registration. The system continues to be plagued by both underregistration and incomplete coverage. The population in areas not under compulsory registration is estimated to be only about 1.5 percent of the total, but the noninclusion of data from defaulting registration units reduces the extent of population coverage at the national level to about 70 percent (India, Registrar General, 1972a, 1978). The coverage is especially poor in the rural areas of Rajasthan, Bihar, and Uttar Pradesh and only moderate in West Bengal, Karnataka, and Andhra Pradesh. Comparison of rates with those derived by the Sample Registration System indicates that the extent of underregistration is about 40-50 percent at the national level with wide variations among the states (India, Registrar General, 1978). States with more complete registration systems are Punjab, Maharashtra, and Tamil Nadu. There is no clear-cut difference between the completeness of birth registration and that of death registration. There are also indications from intercensal population analysis that the registration system, instead of improving, has been deteriorating (Mehrotra, 1968; India, Registrar General, 1964b). Estimates of underregistration for the period 1941-50 are lower than estimates for more recent periods.

This pattern makes the analysis of trends from civil registration data almost impossible. According to one observer (Ghosh, 1956), the large increase in population was an important factor in the deterioration of civil registration as it increased the work load of the village headman or *chowkidar* (watchman) responsible for registration work. The fact that provinces with rapid increases in population also recorded maximum reductions in their registration-based birth rates (Ghosh, 1956) has added considerable weight to the argument. Since the mid-1950s the reorganization of states and subsequent attempts to unify varying provisions existing in different parts of the state have apparently led to its further deterioration (India, Registrar General, 1964b, 1966). The *Panchayats*, village-level civic bodies that took over the work of registration in most states, had neither the necessary personnel nor the zeal to undertake the arduous task. With no sign of quick recovery in sight, the Registrar General of India introduced the Sample Registration System as an alternative.

1.3 SAMPLE REGISTRATION SYSTEM

The Sample Registration System in India (SRS) is a dual-record system with the main objective of providing reliable estimates of birth and death rates at the national and subnational levels. The SRS was initiated by the Registrar General on a pilot basis in a few selected states in 1964-65 and was expanded rapidly to cover almost the entire country by 1971.

The field investigation of the SRS consists of continuous enumeration of births and deaths by an enumerator and an independent survey every six months by an investigator-supervisor. A complete listing of houses and households is made by the enumerator, which is updated at each half-yearly survey by the investigator to obtain the current population. An enumerator (recorder), usually a schoolteacher resident in the area, is appointed for each sample unit and is paid a small honorarium for this work. He is expected to record the births and deaths occurring in the sample area as well as those occurring to usual residents of the sample area who are temporarily outside it. Events occurring to visitors within the sample area are also noted but are not considered for computing vital rates. Thus the events to be recorded by the enumerator include: usual resident present in the sample unit (URP); usual resident absent from the sample unit (URA); and visitors living in the sample unit (V). For ensuring complete recording of events, the enumerator uses several means to keep informed about the occurrence of events in the sample area. These include an informant system in which the enumerator consults a village dai (midwife) or a chowkidar (village priest), who reports the occurrence of events. The enumerator is expected to maintain a list of pregnant women, make house-to-house visits in urban areas and quarterly rounds in rural areas, and make visits to hospitals, primarily health centers and burial grounds.

The investigator conducts the six-month retrospective survey in January and July of each year. He is expected to list all births and deaths pertaining to usual residents (both URP and URA) and to visitors (occurring within the sample unit) during a fixed period of six months. Simultaneously he updates the household population listed in the household schedule by adjustment for births, deaths, and migration. He also pays periodic visits to the sample unit to supervise the work of the enumerator and to provide necessary guidance and clarifications.

After the completion of the six-month survey, the two sets of records of the enumerator and the investigator are matched event-by-event at the state or district headquarters and classified as matched, partially matched, or unmatched. Criteria for matching are agreements on location of the household, the name of the head of the household and name of the mother for births and the name of the deceased for deaths, residential status

(URP/URA/V), sex, and month of occurrence of the event. After the initial matching, the partially matched and unmatched events are reverified in the field to determine the correct allocation. The reverification is generally done by an independent official. Thereafter, an unduplicated count of births and deaths is obtained. No attempt is made to estimate the number of events missed by both the enumerator and the supervisor. The SRS operates in 3,700 sample units selected from the 1961 census frame, of which 2,400 are rural areas. It covers a population of 4.2 million, representing about 0.7 percent of the rural population and 1 percent of the urban population. In 1976-77, another 1,700 sample units were added from the 1971 census frame to the existing sample units with a view to increasing the precision of the estimates. The total population covered in 1981 was over 5.7 million (Padmanabha, 1981).[1]

In recent years the SRS has become the most important source of demographic information in India. Much of this report in effect constitutes an evaluation of how well it is performing, since it contains comparisons of SRS-based estimates with those derived from other sources. Like any data system, the SRS is subject to many kinds of errors. According to the Registrar General (Padmanabha, 1981:18):

> Among the causes that contribute to non-sampling errors in the SRS may be mentioned the fact that some of the sample units are not easily accessible which often results in the enumerator attempting to avoid carrying out the survey in full, lack of rigor in supervision due to the survey deteriorating into a routine which, incidentally, also affects training, the ennui of the enumerator over a period of time due to the long retention of a given sample and the decrease in the interest of the household itself due to the constant visits of the enumerator. The non-sampling errors that arise due to these contributory causes cannot be quantified but do have an effect on the quality and, consequently, the results of the survey.

It seems worthwhile at the outset to summarize the results of direct attempts to evaluate the completeness of the SRS reports. Table 6 is a synopsis of the six main investigations whose results have been published. A wide range of SRS omission rates is indicated; however,

TABLE 6 Summary of Direct Evaluations of the Completeness of SRS Records of Births and Deaths: Selected States and Areas of India

Area	Dates	Percentage of Events Omitted by SRS		Comments
		Births	Deaths	
Kerala	1966-67	8.0	5.0	Showed omissions to be greater in larger villages
Kurnool District (Andhra Pradesh)	1968	2.0	0.0	Covered only area of about 3,000 population for 6 months
Jammu and Kashmir	1968	13.3	7.5	Omission overstated relative to standard SRS procedures because it refers to events missed by enumerators; there was no half-year survey by supervisors
Assam	1972 Rural	2.4	3.4	Showed "usual resident absent" births and deaths to be at somewhat higher risk of omission in rural areas than "usual resident present"
	1972 Urban	5.8	5.2	
Andhra Pradesh--Urban	1973-74	7.7	9.2	Conducted during period of SRS disruption. Showed one-half of missing births were from "usual resident absent"
Karnataka	1977	18.7	9.9	Comparison data not strictly comparable to SRS but based on non-random sample of health districts using dual-record system with very low match rate.

Sources: Kurup (1968); Sastry and Raju (1968); Gani and Kalla (1969); Puri (1974); Lal and Swamy (1976); Shariff et al. (1979).

the two studies showing the largest omission rates are of questionable relevance. The study of Jammu and Kashmir investigated an early form of the SRS in which all data were gathered by enumerators; there was no half-yearly survey by supervisors. In fact, for all-India during 1970-72, the supervisor alone uncovered 11.8 percent of the total recorded rural births and 11.7 percent of the deaths (India, Registrar General, 1973), which are roughly equivalent to the omission rate in the Jammu and Kashmir study of the SRS. The study in Karnataka was not a direct inquiry into SRS villages but was based on primary health centers. It is not clear what steps, if any, were taken to ensure comparability to SRS villages. Furthermore, the study, using a dual-record design, achieved an extremely low match rate of 41 percent for births and 24 percent for deaths, which reduces the reliability of results.

One of the other studies, in urban Andhra Pradesh, was conducted explicitly to investigate the extent of deterioration in the SRS coverage during 1973-74. In 1973 the regular half-yearly survey for July-December was postponed and conducted at the same time as the half-yearly survey for January-June 1974. At about the same time, SRS local budgets came under increased stress, which may have inhibited (e.g., through transport restrictions) the enumeration of vital events. In addition, a vigorous sterilization campaign in 1973 may have reduced the incentive of field workers to report births. Thus, the omission rates of 8 percent for births and of 9 percent for deaths may not be typical of other periods, although they surely suggest caution in dealing with rates for the 1973-74 period. The remaining three studies of SRS performance indicate omission rates for births ranging from 2-8 percent and for deaths from 0-5 percent. There is, of course, no guarantee that these studies uncovered all of the vital events that occurred. And birth and death rates can also be overstated to the degree that the population at risk is underestimated.

Initially there also was a plan to conduct once every 3 years a comprehensive fertility survey in the sample registration units during the regular half-yearly surveys. So far, however, only one such survey was conducted, in 1972, and this report makes extensive use of the results of that retrospective inquiry in arriving at estimates of fertility and mortality levels in India. The 1972 Fertility Survey was conducted in 25 percent of the households in the SRS sample villages and urban blocks and covered 0.23 million ever-married women (India, Registrar General, 1976b). Although no information was gathered on detailed pregnancy histories of the women, significant data were collected to study levels and differentials in fertility and child mortality. In the beginning of 1979, a survey on infant and child mortality was conducted on 2,338 rural sample units of the SRS and 1,328 urban blocks. A total of 4.187 million people were included in the area sampled. An advance report based on a 25-percent sample of the areas included was available at the time of the writing of this report (India, Registrar General, 1980a). It contained data useful for both fertility and mortality estimation, although the questionnaire design was less satisfactory for both than was the case for the 1972 Fertility Survey.

Analysis done for the panel as well as the Registrar General's own evaluation suggests that completeness of sample registration is substantially below the all-India average in Bihar and West Bengal. These states reported 106 million people in the 1971 census, 19 percent of India's total. It was necessary in many of the tables in this report that are based on SRS data to exclude these states; an adjustment is made for the effects of this exclusion at the all-India level.

1.4 NATIONAL SAMPLE SURVEYS

The National Sample Surveys (NSS), an ongoing series of socioeconomic surveys, have collected information on births and deaths during some specified time period through retrospective single-round interviews on a more or less regular basis since its seventh round, in 1953-54. Prior to the inception of the SRS, the NSS-based estimates played a significant role in the formulation of such national policies as the five-year plans. A detailed account of the demographic data collected in various rounds of the NSS is available in Das and Bhattacharya (1977).

In recent years, the introduction of the SRS has pushed NSS demographic inquiries into the background. Although NSS estimates of demographic indices are markedly better than those from the civil registration system, NSS-SRS comparative studies indicate that the NSS data are affected considerably by the omission of events due to recall lapse and the heavy work load of NSS investigators (India, Registrar General, 1972b).

In several rounds, however, the NSS has collected valuable data on children ever born and children surviving from which indirect estimates of child and infant mortality levels could be derived. The questions on these were first incorporated into the NSS schedules in the 16th round (1960-61), and information on these were obtained as well as other demographic particulars in every round through the 23rd (1968-69). Unfortunately, however, the tabulation of these data was done only twice--for the 16th (urban India only) and the 20th rounds (India, Cabinet Secretariat, 1967; India, National Sample Survey Organisation, 1975). Information available from the 20th round (1965-66)--which to our knowledge had never been examined--proved to be an extremely important ingredient in the set of estimates included in this report. Using a self-weighting design at the state level, this survey covered a total of about 154,000 households in rural areas and about 93,000 households in urban areas of India.

It should be noted that state-level estimates made for the panel did not in general prove satisfactory for the years before 1961. Demographic information from sources other than censuses was usually not sufficient to provide a strong test of census-based estimates, and the latter did not possess the internal consistency and coherence that would allow them to stand alone. Therefore, the panel's estimates in general are based on data beginning with the 1961 census. Earlier data are sometimes introduced, particularly in the section in Chapter 2 on infant and child mortality, to help resolve disagreements between later data sources.

Unfortunately, the full results of the 1981 census are not available at this time. These results will be very important for understanding the general level of vital rates during the 1971-81 decade. However, the results that are available from the 1981 census--sex ratios and growth rates, for example--have played an important role in several parts of the analysis. The age distribution for a sample of the population became available only as this volume went to press, so it was not possible to integrate the distribution fully into the analysis; however, its message was instrumental in guiding our choice among competing alternatives.

1.5 SUMMARY OF ANALYSIS

This report first considers estimates of infant and child mortality because these are important ingredients in estimates of other demographic parameters. Estimates derived from two fertility surveys conducted during the 1970s are compared with those developed from the National Sample Surveys in the 1960s as well as to death rates produced through the Sample Registration System. Data drawn from earlier censuses were used to test the validity of results, and a variety of internal consistency checks were also employed.

The major conclusion, heretofore undocumented, is that a large decline in child mortality occurred during the 1960s. It is estimated that the probability of dying before age 2 declined from .225 about 1961 to .164 about 1968. The 1968 figure is derived from a 1972 survey. A 1979 survey shows a continued rapid decline in child mortality to a q(2) of .125-.143 (for approximately 1975), but such a large decline is inconsistent with other available information, particularly age-specific rates derived from the SRS. Latest SRS figures show probability of dying before age 1 of .131 in 1976-77 (compared with .132 in 1970-72) and a death rate below age 5 of .0509 in 1977 (compared with .0546 in 1970-72). The choice between these alternatives could not be made with any confidence until the census age distribution was released, and it supported the survey results.

Section 2.2 in Chapter 2 addresses the quality of information available on SRS adult mortality and crude death rates. The major quality checks available are tests of consistency with observed age distributions and growth rates. These tests suggest that SRS counts of adult deaths are about 10-percent deficient, although a wide range of estimates results from relatively small modifications in the tests. Male deaths appear to be somewhat more completely registered in the SRS than female deaths, and in this report we adopt figures of .93 for registration completeness of males and .87 for that of females. It is unlikely that mortality of children is more completely registered than that of adults, so the figure of 10-percent underregistration is also used to correct crude death rates. However, the recorded SRS death rates below age 5 are subject to an offsetting bias, that of age overstatement that might deprive the age group 0-4 of its lowest-mortality segment. In the early part of the 1970s, survey data confirm the general levels of under-5 mortality recorded in the SRS. Therefore, in producing life tables from SRS data, no corrections were made below age 5. Life expectancy at birth for all-India (except Bihar and West Bengal) based on corrected SRS data for 1971-73 is 48.5 years for males and 46.2 for females (Table 43). Corresponding figures for 1977 are 49.8 and 47.6, showing very little change over that 6-year period. It is likely, however, that a sizable improvement occurred in 1979 because SRS crude death rates declined by 13 percent between 1977 and 1979. Male life expectancies at age 5 are 56.1 years in 1971 and 57.0 in 1977, and corresponding female values are 55.0 and 56.1.

Section 2.3 in Chapter 2 deals with fertility estimation from the 1972 and 1979 surveys and from SRS data. The analysis is complex for reasons related to data inadequacies, which could best be mitigated at the state level. In particular, marital distributions in the 1972 Fertility Survey are out of line with those in the 1971 census. Making appropriate corrections and comparing reported births in the past year with lifetime births reported in the 1972 survey for each state produces a corrected total fertility rate for all-India of 5.60 in 1971-72 and a crude birth rate for the same period of 39.3 per 1,000. These are accepted as the most reliable estimates of fertility for the period. They imply that SRS births are underregistered by about 7.8 percent for the 1970-73 period. Assuming that this correction factor applies throughout the decade to SRS birth rates produces a crude birth rate of 36.0 in 1979, the latest year for which figures are available. However, there is some indication that SRS "completeness" may have improved during the 1970s, so that the 1979 figure should be lower.

The 1979 survey does not appear to produce a plausible fertility level. The crude birth rate in the survey is lower than that in the uncorrected SRS figures. The reported total fertility rate of 4.30 is far out of line with the 5.60 estimate for 1971-72, particularly in view of the more modest declines in SRS crude birth rates. The inadequacies of the 1979 survey probably result from the manner in which fertility questions were asked, the failure to include births omitted by the enumerators but counted by supervisors, and the population's suspicions about the motives for asking questions about fertility.

However, we believe that a reasonable correction of the 1979 survey is possible by a direct comparison of mean parities and mean births-last-year in the 1972 and

1979 surveys. This comparison suggests a total fertility rate of 4.69 for 1978. Such analysis of the 1961-71 intercensal period is the main subject of Chapter 3. The later period could only briefly be examined through intercensal analysis because of the late arrival of the 1981 age distribution. Intercensal analyses for 1961-71 have been performed by many others. What is new about the present version is the introduction of more solidly based information on child mortality than was used before. The estimated vital rates for 1961-71 (mean of forward and backward survival) are 41.0 for the crude birth rate, 18.8 for the crude death rate, and 5.72 for the total fertility rate (estimated indirectly by using the age pattern of fertility from the 1972 Fertility Survey). Life expectancy at birth is estimated at 46.8 for males and 45.2 for females. Life expectancy at age 5 is estimated to be 55.4 for males and 53.7 for females. A comparison of 1961 and 1971 censuses by cohorts, together with an early life table computed from the SRS, suggests that the sex ratio of the 1971 census may have been depressed relative to 1961 by the selective omission of females in 1971.

Before accepting the estimates in Chapters 2 and 3 as final, we have subjected them in Chapter 4 to two additional tests. The first is a comparison of estimates for the 1971-81 decade to recorded 1971-81 intercensal growth. The decadal crude birth rate from the SRS (corrected for underregistration) is 37.4; the SRS crude death rate for the 1971-80 decade, corrected for underregistration, is 16.3. The implied crude rate of natural increase for the decade is 21.1 per 1,000, compared to the recorded intercensal growth rate of 22.2 between 1971 and 1981. It is believed, however, that the intercensal growth rate might be overstated by perhaps 0.4 per 1,000 by the differential omisson of females from the 1971 census, increasing the consistency between our estimates of vital rates and the observed intercensal growth rate.

The second test is more complex. It involves estimating the true age distribution of India in 1966 and projecting that age distribution forward to 1981 by age-specific rates of birth and death estimated for various five-year periods. Two projections were made with differing levels of mortality because of the inconsistency between survey and sample registration estimates of mortality. Comparison of results to 1971-81 population change supported the low-mortality scenario.

NOTE

1. According to a recent announcement (Registrar General's *Newsletter*, January 1982), about 58 percent of the old sample units based on the 1961 census have been replaced by new sample units drawn from the 1981 census frame, effective January 1, 1982.

2 ESTIMATES BASED ON THE SAMPLE REGISTRATION SYSTEM AND SURVEYS

2.1 INFANT AND CHILD MORTALITY

Estimation of infant and child mortality is a convenient point of entry into the total estimation process, since several other aspects, especially intercensal analysis, are heavily dependent on it. There are three sources of information on infant and child mortality by states in India that provide a relatively firm basis for estimation. One is the Sample Registration System which has a permanent machinery for the enumeration of vital events. The other two are the 1972 Fertility Survey, conducted in SRS villages by SRS field staff, and the 20th round of the National Sample Survey (1965-66). Both of the latter permit indirect estimation of infant and child mortality since they inquire of women the number of children ever born to them and the number surviving to the time of the interview. An additional source of data is available only at the all-India level: the Survey of Infant and Child Mortality, carried out on the eve of the International Year of the Child, again using SRS villages and machinery (India, Registrar General, 1980a, 1980b).

2.1.1 Sample Registration System

Unadjusted data from the Sample Registration System are presented in Table 7. Data for 1973 and 1974 are omitted because of evidence that the SRS performance during those years was below standard. It should also be borne in mind that the SRS was just beginning in some areas in 1970-72 and that data for these years may be liable to greater error than those for later dates, particularly for infant mortality. Thus the registered rise in infant

TABLE 7 Infant and Child Mortality Data from the Sample Registration System: Selected States and All-India

State	Annual Mean, 1970-72		Annual Mean, 1975-76		Percentage Change, 1970-72 to 1975-76	
	Infant Mortality Rate	Death Rate Ages 0-4 ($_5M_0$)	Infant Mortality Rate	Death Rate Ages 0-4 ($_5M_0$)	Infant Mortality Rate	($_5M_0$)
Andhra Pradesh	112	45.0	121	49.1	+8	+9
Assam	134	50.2	134	46.4	0	-8
Gujarat	142	63.7	150	56.8	+6	-11
Haryana	81	31.9	111	45.8	+37	+43
Himachal Pradesh	122	--	121	--	-1	--
Jammu and Kashmir	76	21.9[a]	68	33.4	-10	+52
Karnataka	95	36.9[b]	85	28.6	-11	-22
Kerala	58	24.6[b]	55	19.4	-5	-21
Madhya Pradesh	145	35.3	145	36.0	0	+2
Maharashtra	101	40.8	87	33.1	-14	-19
Orissa	130	57.1	138	53.5	+6	-6
Punjab	107	40.4[b]	103	35.9	-4	-11
Rajasthan	128	60.2[a]	148	60.8	+16	+1
Tamil Nadu	120	45.1	111	43.8	-7	+3
Uttar Pradesh	174	85.7	188	84.5	+8	-1
All-India (except Bihar and West Bengal)	132	54.6[b]	135	51.0[c]	+2	-7

[a] 1972 only.
[b] 1971 and 1972 only.
[c] 1976 only.

Source: Data supplied to panel by Registrar General of India.

mortality between 1970-72 and 1975-76 may be spurious. In this regard it is noteworthy that Uttar Pradesh, Gujarat, and Rajasthan, which recorded substantial increases in infant mortality, experienced either decreases or much smaller increases in mortality below age 5. These are three of the four states (with Madhya Pradesh) that had the highest omission rates of infants in the 1971 census as judged from a match of census records with births recorded in the SRS (India, Registrar General, 1977c). The fact that the rise in infant mortality between 1970-72 and 1975-76 tended to be largest in states in which enumeration of infants is least satisfactory suggests that infant mortality rates in these states in 1970-72 may have been somewhat underestimated by the SRS. It does not seem likely that the infant mortality rate for all-India actually rose between those years, particularly since recorded $_5M_0$ declined by 7 percent despite some clear improvements in data quality (e.g., in Haryana and Jammu and Kashmir). As noted in Section 2.2, however, it is also possible that the incongruent decline in $_5M_0$ was a result of improving age statement in the early years of the SRS.

Before presenting equivalent information from other sources, it is useful to note that, from virtually any data set, India has high mortality below age 5 relative to mortality above age 5. The two model life table systems having this feature in the Coale-Demeny set of model life tables are the "East" and the "South" (Coale and Demeny, 1966). Of these two, the South was found to be far more representative of the SRS relations between $_1q_0$ and $_5M_0$ for the large majority of Indian states. The south model is therefore used throughout most of this section.

2.1.2 Estimates from CEB/CS Data

Table 8 presents a variety of child mortality estimates for all-India that are based on the information on children ever born (CEB) and children surviving (CS) to ever-married women collected in the NSS for 1965-1966, in the 1972 Fertility Survey, and in the 1979 Survey of Infant and Child Mortality. Methods adopted in converting the information available in each survey to life table parameters vary slightly and merit some attention. The CEB/CS data from the 1965-66 NSS are tabulated by effective duration of marriage; the duration intervals used

TABLE 8 Estimates of Infant and Child Mortality from Data on Children Born and Surviving of the 1965-66 NSS, the 1972 Fertility Survey, and the 1979 Surveys of Infant and Child Mortality: All-India

	1965-66 NSS (all religions)		1972 Fertility Survey		1979 Survey of Infant and Child Mortality		Time Reference of q(x) Values (years before survey)	
Age (x)	q(x)	South Level	q(x)	South Level	q(x)	South Level	1972 Fertility Survey	1979 Survey of Infant and Child Mortality
1	n.a.	n.a.	.130	13.8	.152	11.6	1.1	1.0
2	.225	10.6	.155	14.9	.143	15.7	2.4	2.1
3	.251	10.7	.175	14.7	.137	17.0	4.2	3.9
5	.277	10.2	.185	14.9	.145	17.1	6.4	6.1
10	.317	10.0	.203	14.7	.160	16.8	8.9	8.5
Graduated q(2)	.225		.154		.125		4.3[a]	4.0[a]

Note: n.a. = not available.

[a] Average of the estimates for q(2), q(3), and q(5).

Sources: India, National Sample Survey Organisation (1975); Dyson (1979b); India, Registrar General (1980b).

are 0-5, 6-9, 10-15, 16-25, 26-35, and 36 and above.[1] Since these intervals are unconventional, a new set of multipliers developed by Hania Zlotnik was used in the conversion of CEB/CS data into q(x) values (see Appendix A). In the 1972 and 1979 surveys, CEB/CS data are tabulated by age of mother. The values of q(x) were derived from the 1972 Fertility Survey using Trussell's "South" model coefficients (Trussell, 1975). South coefficients were also applied to all-India results from the 1979 survey.

The estimates presented in Table 8 for all-India from the 1972 Fertility Survey are not computed directly from the figures given in the Registrar General's publication but are derived as weighted averages of state-specific values of dead and surviving children.[2] Computations based directly on the source data (not shown) consistently give results well below the state average (except for q(1)), and it was not possible to identify the source of the discrepancy. The "graduated" values of q(2) are derived by identifying the level of mortality within the South model life table system corresponding to q(2), q(3), and q(5) and taking the value of q(2) in the model life table located at the average of those levels.[3] The time periods to which the various estimates of q(x) relate have been computed using the Coale-Trussell procedure (Coale and Trussell, 1978). These time periods could not be computed for the 1965-66 NSS because of its irregular tabulations; however, they should not be significantly different from the ones estimated for the later surveys.

A striking feature of the estimates presented in Table 8 is that, while comparison of q(x) values within surveys fails to reveal any real decline in child mortality (as indicated by the approximate constancy of estimated "levels"), comparison across surveys reveals substantial decline in child mortality, especially between the 1965-66 NSS and the 1972 Fertility Survey. This contradiction was not a product of the choice of model life table systems but persists regardless of which system is used. The main possible explanations are that a real decline in mortality was masked by the increasing omission of dead children by older women when q(x) values of the same survey are compared; or that a spurious decline is implied when estimates from the NSS and other surveys are compared because of either underestimation of mortality in the other surveys or overestimation of mortality in the NSS.[4] By showing little trend, the major additional source of data--SRS child death rates--gives some support to the latter possibility, although it is not very informative for the earlier period.

According to our estimates, under a regime of declining mortality the graduated value of q(2) refers to a period approximately 4 years before the survey. Thus, the graduated value of q(2) from the 1965-66 NSS relates to about 1961, that of the 1972 Fertility Survey to about 1968, and that of the 1979 Survey of Infant and Child Mortality to about 1975. If the estimates from the three surveys are comparable, then the implication is that the probability of dying before one's second birthday declined from 0.225 in 1961 to 0.154 in 1968 and further to 0.125 in 1975. Such a huge decline in child mortality between 1961 and 1968 would have had to occur in a period of modest economic gains, a period that also saw at its end a resurgence of malaria in many parts of India.[5]

Two differences in the manner in which the surveys were conducted could have exaggerated the appearance of mortality decline between 1961 and 1968. One is a difference in questionnaire design. In the 1965-66 NSS, enumerators first asked each woman "number of children born alive but since dead" and then "number of children now alive" and "total number of children." The 1972 Fertility Survey reversed the order of the first two questions. Unlike the 1965-66 survey, it also asked separately about the number of children now living at home and the number now living elsewhere. It may therefore have elicited more living children, while the reordering of questions may have reduced the number of dead children reported. Both tendencies would have reduced estimated mortality. It should be noted that the 1979 inquiry asked only "total children born alive" and "total children surviving" without a direct question on the number of dead children or on the number of children living at home or away. The absence of these specific questions has probably biased downward the total volume of mortality as well as of fertility estimated from the 1979 survey. In addition, there have been suggestions that questions about fertility in surveys during the late 1970s have generated suspicion on the part of respondents about the interviewer's motives and have lead to downward bias.

The second difference is that the 1972 Fertility Survey results were tabulated by age and the 1965-66 NSS were tabulated by duration of marriage. Indirect estimation procedures should work about equally well in the two cases. However, data by duration of marriage were reported not only for currently married women in their first marriage but also for remarried women and separated, divorced, or widowed women. Remarried women were treated properly from the point of view of mortality estimation: their duration of marriage was recorded from the date of first marriage to the survey date. However, the other women were assigned their marital duration at the time of disruption, so that the inferred amount of exposure of their children to the risk of mortality is biased downward. We have done a relatively extensive simulation of the possible magnitude of this bias in the all-India figures from the NSS because of its potential importance. We have assumed that the age structure of the ever-married female population is that of a "West" stable population with a growth rate of .02 and mortality level 8. Female marriage occurs at age 16. Husbands are assumed to be 5 years older at marriage and to have mortality level 11. With no remarriage, the proportion of people reported at duration 0-5 by the NSS tabulation would include 15 percent who are widowed and really belong to higher intervals; the figures are 16 percent at 6-9 and 17 percent at 10-15. These people would have married, on the average, 25, 28, and 32 years before the survey, which is an upper limit on the exposure of their children to mortality. Adopting a West model life table, they bias upward the proportion of children dead (and associated q(x) values) by 12 percent, 14 percent, and 11 percent, respectively. A majority of this bias, however, is eliminated by allowing remarriage, the frequency of which for women in India is adapted from Bhat and Kanbargi (1984). After adjustment for remarriage, the bias in proportion of children dead at 0-5, 6-9, and 10-15 years of marriage is, respectively, 4.2 percent, 5.9 percent, and 1.1 percent. This could explain only a small fraction of the 46 percent difference in graduated q(2)s between the 1965-66 NSS and the 1972 Fertility Survey; however, the bias could be larger (or smaller) in certain states.

A cross-check is also possible to ascertain the magnitude of the bias in child mortality estimates derived from the 1965-66 NSS. The data on children ever born and children surviving from the 16th round of the NSS (1960-61), available only for urban, currently married women, has been tabulated by age (India, Cabinet Secretariat, 1967). Estimates of q(x) values computed from this data could be readily compared with those derived from the 1965-66 NSS for urban India:[6]

Source	q(2)	q(3)	q(5)	q(10)	Graduated q(2)
NSS 16th round (1960-61)	.209	.213	.224	.294	.192
NSS 20th round (1965-66)	.176	.194	.231	.281	.178

The above comparison strongly supports the belief that the classification of widowed, divorced, and separated women according to their marital duration at the time of disruption has not significantly distorted the estimates of child mortality derived from the 1965-66 NSS. It also supports the relatively high values of child mortality found in the 1965-66 NSS for all-India.

The suspicion that the 1979 survey understated the actual levels of child mortality in the mid-1970s becomes stronger when the individual q(x) estimates from the 1972 and 1979 surveys are compared across cohorts. As the two surveys were exactly separated by 6.5 years in time, the estimate of q(1) from the 1972 survey and the estimate of q(2) from the 1979 survey, the estimate of q(2) from the 1972 survey and the estimate of q(3) from the 1979 survey, and so on, are approximately based on the experiences of children in the same cohorts of women. The examination of Table 8 (above) in this light reveals that, except for age 2, the estimates from the 1979 survey are lower than the corresponding lagged values from the 1972 survey. While a part of the discrepancy can be attributed to the fact that the interval between the surveys was greater than 5 years, a more probable reason seems to be that as women became older, they increasingly failed to report accurately the number of dead children. Thus the estimates of q(x) beyond age 2 from the 1979 survey and the graduated q(2) based on them are probably too low.

Even if we are to consider the ungraduated q(2) estimate of 0.143 from the 1979 survey as relatively free from the underreporting errors that plauge the estimates for older ages, it implies much lower level of child mortality than the estimates directly available from the SRS. The q(2) estimate of 0.143 referring approximately to the period 1976-77, when transformed via the South model life table system, implies a death rate of 39.2 for the interval 0-4 and an infant mortality rate of 112. The corresponding estimates from the SRS for the period are 51.0 and 129, respectively. Thus, if we are to accept the q(2) value of 0.143 from the 1979 survey as reasonably accurate, we have to confront the possibility that the SRS was overestimating mortality in the mid-1970s, perhaps as much as by 15-30 percent under age 5. Indeed, that such a tendency in the SRS is not outside the realm of possibilities is also suggested by the intercensal survival analysis carried out for the decade 1971-81 in Chapter 3.

While a similar cohort comparison can be made for the estimates of the 1965-66 and the 1972 surveys, the interpretation is not as clear-cut as it was in the earlier case since the 1965-66 survey classified the data by duration intervals while the latter surveys used age categories for the classification. Instead, to cast further light on the validity of the levels and the implied trend, we examine the state-specific estimates of child mortality derived from the 1965-66 and 1972 surveys. The estimates of q(x) values computed from the CEB/CB data of the 1965-66 NSS and the 1972 SRS Fertility Survey for 15 major states of India appear in Tables 9 and 10. In the case of the 1965-66 NSS the requisite tabulations at the state level were available for Hindu households only (whereas the national figure was presented for all religions combined). The estimates of child mortality derived from this survey are therefore strictly applicable only to the Hindu population of the respective states. In 11 of the 13 major states (the exceptions are Punjab and Kerala), more than 70 percent of the population is Hindu.[7] As we demonstrate below, the estimates of child mortality derived from the 1965-66 NSS for Punjab and Kerala, where the Hindu proportion is low, seem to be largely consistent with the estimates derived from other sources. Inconsistencies are seen mainly in the estimates for certain other states, where the proportion of Hindu population is high.

Without losing much information, we may focus our attention only on graduated q(2) values computed from the estimates of q(2), q(3), and q(5). In passing, however, we may note that the comparison of q(x) estimates presented in Tables 9 and 10 reveals that q(x) estimates derived from the 1965-66 NSS are internally more consistent than those from the 1972 Fertility Survey, giving one reason for placing more confidence in the estimates derived from the 1965-66 NSS.

TABLE 9 Child Mortality Estimates by State from the 1965-66 NSS, Using the Regression Coefficients in Appendix A, Hindu Households Only: Selected States and All-India

State	Percent Hindus (1961 census)	q(2)	q(3)	q(5)	q(10)	Graduated q(2)
Andhra Pradesh	88.4	.239	.244	.276	.307	.227
Assam	71.3	.168	.168	.188	.194	.161
Bihar	84.7	.250	.275	.280	.314	.241
Gujarat	89.0	.159	.197	.240	.269	.175
Haryana	88.9	.200	.207	.257	.300	.197
Karnataka	87.3	.205	.232	.254	.291	.206
Kerala	60.8	.131	.159	.170	.210	.135
Madhya Pradesh	94.0	.264	.277	.314	.361	.256
Maharashtra	82.2	.223	.239	.264	.308	.219
Orissa	97.6	.274	.238	.278	.318	.236
Punjab	42.3	.179	.211	.187	.234	.168
Rajastham	90.0	.250	.260	.299	.361	.242
Tamil Nadu	89.9	.219	.250	.270	.290	.220
Uttar Pradesh	84.7	.351	.378	.392	.430	.341
West Bengal	78.8	.176	.178	.201	.258	.164
All-India (Hindus)	83.5	.232	.258	.283	.323	.231

Note: Separate estimates for rural and urban areas were combined employing the Hindu population (1961 census) in the respective areas as weights.

Source: Computed from India, National Sample Survey Organisation (1975).

The graduated q(2) values derived from the 1965-66 NSS and the 1972 Fertility Survey given in Table 11 are very consistent in their rank ordering of states, with northern states generally showing higher levels of child mortality than southern states. The figures also imply a large decline in child mortality in the states of Haryana, Bihar, Maharashtra, and Karnataka (more than 40 percent). A reduction by one-third or more is also implied in the states of Kerala, Tamil Nadu, Uttar Pradesh, and West Bengal. Whether these huge reductions in child mortality are real or spurious is difficult to ascertain. The little internal evidence available from the SRS does not support a large decline in child mortality, at least in the late 1960s. With the possible exception of Kerala, no sign of a significant reduction in infant mortality is observed in rural areas of the four states in which the SRS has been in full-scale operation since 1965-66:

State	Infant Mortality Rate (Rural) 1965-66	1970-72
Gujarat	147	151
Kerala	74	61
Karnataka	106*	103
Maharashtra	101	109

*Relates to 1966-77
Sources: Agarwala (1969); India, Registrar General (1975b, 1977d).

This impression is essentially maintained even for the states in which the operation was only on a pilot scale in the mid-1960s. The evidence, however, is subject to the qualification that the SRS had just begun in the late 1960s, and whatever decline had occurred may therefore have been masked by the improvements in enumeration. Another difficulty with the evidence is that, while infant mortality has remained constant, mortality at ages 1-2 could have declined, as happened in England and Wales in the late nineteenth century (McKeown and Record, 1962).

In the states in which a very large decline in child mortality has occurred, the estimates of q(x) values from the 1972 Fertility Survey should imply progressively lower levels of mortality as x increases. To examine whether this is actually the case we have computed graduated q(2) values from q(2) and q(3) estimates as well as from q(5) and q(10) estimates, under the assumption of a South model mortality pattern (see Table 12). The computation of graduated q(2) values has the advantage of reducing the effects of sampling errors in the q(x) estimates. Except for Kerala, none of the states in Table 12 shows any sign of a large reduction in child mortality in the years preceding the survey. In fact, for most states, the possibility of an increase in child mortality is indicated, perhaps due to more underreporting of dead children among older women or to an incorrect choice of the South model pattern.[8] However, unless progressive increase of underenumeration of dead children with age of mother was greater in the states in which the reduction of child mortality was greater, we should still expect a high degree of correlation between the ratios of graduated q(2) values of Table 11 and Table 12. The fact that

TABLE 10 Child Mortality Estimates by State from the 1972 SRS Fertility Survey, Using Trussell's Regression Coefficients on the Assumption of a South Mortality Pattern: Selected States and All-India

State	q(1)	q(2)	q(3)	q(5)	q(10)	Graduated Values of q(2)
Andhra Pradesh	.167	.168	.168	.188	.194	.155
Assam	.156	.172	.166	.186	.191	.155
Bihar	.038	.125	.149	.161	.165	.128
Gujarat	.139	.169	.182	.201	.222	.163
Haryana	.121	.111	.105	.131	.144	.101
Karnataka	.094	.123	.135	.146	.148	.119
Kerala	.062	.074	.218[a]	.121	.158	.084[b]
Madhya Pradesh	.157	.189	.192	.203	.222	.173
Maharashtra	.113	.137	.146	.145	.183	.126
Orissa	.184	.229	.201	.203	.226	.188
Punjab	.238	.145	.136	.148	.191	.126
Rajasthan	.123	.164	.186	.319[a]	.214	.164[c]
Tamil Nadu	.136	.162	.150	.149	.177	.136
Uttar Pradesh	.162	.226	.262	.283	.311	.230
West Bengal	.095	.113	.127	.047	.154	.112[c]
All-India	.130	.155	.175	.185	.203	.154

[a] Believed to be biased by a misprint in the baseline data. To be specific, the proportion of children surviving to rural Keralan women aged 25-29 indicated by the figures in India, Registrar General (1976b:74) is out of line both with the figures of other age-groups and the indications of urban women of the same age. In the case of Rajasthan, on page 75 of the same report, the printed number of children born alive to rural women aged 30-34 is unrealistically high by about one child and is out of line with the indications of other age groups; this apparent error produces the high q_5 value for Rajasthan.

[b] Based on q_2 and q_5.

[c] Based on q_2 and q_3.

Source: Dyson (1979b).

this correlation is only +.21 casts some doubt on the validity of a huge decline in child mortality in the 1960s.

Table 11 also shows a comparison of the graduated q(2) values from the two surveys to the q(2) values implied by the SRS infant mortality rate and the death rate below age 5, ${}_5M_0$. In transforming the SRS rates into q(2) estimates, the South model mortality pattern was assumed to be applicable and a suitable correction was applied for the fact that ${}_5M_0$ values from the SRS are weighted by the age distribution under age 5.[9] The estimates presented in Table 11 show a high degree of correspondence

TABLE 11 Comparisons by State of the Estimates of q(2) Derived from the 1965-66 NSS, the 1972 Fertility Survey, and the Infant Mortality Rates and $_5M_0$ of the SRS: Selected States and All-India

State	1965-66 NSS (Hindu households)	1972 Fertility Survey	SRS 1970-72		SRS 1974-76	
			IMR	$_5M_0$	IMR	$_5M_0$
Andhra Pradesh	.227	.155	.144	.156	.158	.167
Assam	.161	.155	.178	.170	.178	.160
Bihar	.241	.128	.129[a]	.130[a]	n.a.	n.a.
Gujarat	.175	.163	.191	.205	.204	.187
Haryana	.197	.101	.096	.119	.142	.158
Karnataka	.206	.119	.117	.133	.102	.108
Kerala	.135	.084	.065	.096	.061	.078
Madhya Pradesh	.256	.173	.196	.129	.196	.131
Maharashtra	.219	.126	.126	.145	.105	.122
Orissa	.236	.188	.172	.188	.185	.179
Punjab	.168	.126	.136	.143	.129	.131
Rajasthan	.242	.164	.169	.196	.201	.197
Tamil Nadu	.220	.136	.156	.157	.142	.153
Uttar Pradesh	.341	.230	.243	.255	.264	.252
West Bengal	.164	.112	.131[a]	.119[a]	n.a.	n.a.
All-India (all religions)	.225	.154	.175	.182	.180	.176
All-India (except Bihar and West Bengal)	.231	.162	.175	.182	.180	.176

Note: n.a. = not available

[a] For 1970 only.

TABLE 12 Examination of Time Trend in Child Mortality Levels by Intra- and Inter-Survey Comparisons: Selected States and All-India

State	1972 SRS Fertility Survey Graduated q(2) Values from		Ratio	Ratio of Graduated q(2) of 1972 Survey to 1965-66 Survey Estimate[a]
	q(2) and q(3)	q(5) and q(10)		
	(1)	(2)	(1) ÷ (2)	
Andhra Pradesh	.157	.147	1.08	.68
Assam	.158	.143	1.10	.96
Bihar	.128	.123	1.04	.53
Gujarat	.165	.162	1.02	.93
Haryana	.101	.103	.98	.51
Karnataka	.120	.110	1.09	.58
Kerala	.074[b]	.104	.71	.62
Madhya Pradesh	.179	.163	1.10	.68
Maharashtra	.132	.123	1.07	.57
Orissa	.202	.164	1.23	.80
Punjab	.131	.127	1.03	.75
Rajasthan	.164	.157[c]	1.04	.68
Tamil Nadu	.146	.123	1.19	.62
Uttar Pradesh	.230	.233	.99	.67
West Bengal	.112	.111[c]	1.01	.67
All-India	.154	.148	1.04	.68

[a] Graduated q(2) values derived from q(2), q(3), and q(5).
[b] Based on q(2) only.
[c] Based on q(10) only.

in both level and geographic pattern between the graduated q(2) values derived from the 1972 Fertility Survey and those computed directly from the SRS rates. The coefficient of correlation between the state-specific estimates from the 1972 Fertility Survey and the averages of the two estimates from the 1970-72 SRS is 0.95. But this high degree of consistency may in part be the consequence of the use of the same infra- structure in the collection of data.

In the beginning of this chapter, we alerted the reader to the possibility that SRS infant mortality rates for Gujarat, Rajasthan, and Uttar Pradesh for the period 1970-72 may be somewhat lower than the levels actually prevailing. Table 11 shows that in these states the 1972 Fertility Survey gives even lower estimates of q(2) than those derived from the SRS infant mortality rates of 1970-72. The use of another model pattern such as West or East could have reversed this ordering, but it is important to note that q(2) estimates derived from $_5M_0$, which are reduced by the choice of the South pattern, are even higher. Other states in which the 1972 Fertility Survey produces a lower estimate of child mortality than does the 1970-72 SRS are Assam, Haryana, Punjab, Tamil Nadu, and West Bengal.

Several other tests were made to evaluate the 1966 and 1972 surveys. Table 13 presents state-specific rural-urban estimates of q(2) values (graduated) from the 1972 Fertility Survey and the 1965-66 NSS. This table also shows urban-rural differences in female literacy by state and an index of the urban bias in health services. Estimates from the 1972 Fertility Survey for the states of Haryana, West Bengal, and Kerala imply negligible rural-urban differentials in child mortality. The relatively small difference in urban and rural child mortality levels in Kerala can be justified on the grounds that its rural and urban females are almost equally literate and that the state has the most equitable distribution of health services between rural and urban areas. Also lending support is the small urban-rural difference in child mortality from the 1965-66 NSS. In the states of Haryana and West Bengal, however, little independent evidence is forthcoming for accepting the 1972 Fertility Survey estimates. In West Bengal medical services are relatively better distributed between rural and urban areas, but there is a large gap between rural and urban literacy levels. It seems more credible that the 1972 Fertility Survey has underestimated child mortality in the rural areas of these two states.

Child mortality estimates for the state of Bihar from the 1972 Fertility Survey are also of questionable validity. While the implied rural-urban differential is large, it is doubtful that child mortality in rural areas of Bihar is even lower than the level prevailing in the urban areas of neighboring Uttar Pradesh; nor is it likely that among the urban areas of India urban Bihar has one of the lowest child mortality levels. By advancing similar arguments, it is also possible to throw suspicion on the estimates of child mortality derived from the 1965-66 NSS for the rural areas of Bihar, Gujarat, and Orissa. In this context it is significant that child mortality estimates from the 1965-66 NSS for the state of Gujarat fall below even the range indicated by the 1970-72 SRS (see Table 9). In Karnataka and Maharashtra, where the implied decline in child mortality was largest, we have not uncovered any evidence to suspect the 1972 Fertility Survey estimates.

TABLE 13 Urban-Rural Differences by State in q(2) Estimates (graduated) Derived from CEB/CS Data: Selected States and All-India

State	1972 Fertility Survey		1965-66 NSS (Hindu households)		Urban-Rural Difference in Percent of Female Literacy (age 5 and over), 1971	Ratio of Proportion of Hospital Beds in Rural Areas to Proportion of Rural Population, 1966-67
	Rural	Urban	Rural	Urban		
Andhra Pradesh	.166	.108	.232	.197	29.3	.11
Assam	.159	.099	.165	.119	39.1	.16
Bihar	.139	.072	.246	.229	29.8	.28
Gujarat	.170	.134[a]	.177	.167	31.6	.39
Haryana	.103	.091	.207	.149	37.0	.25
Karnataka	.127	.094	.218	.155	31.2	.20
Kerala	.089[b]	.071	.135	.132	8.1	.44
Madhya Pradesh	.188	.109	.262	.217	36.5	.19
Maharashtra	.130	.117	.235	.150	34.0	.05
Orissa	.193	.140	.236	.234	28.4	.40
Punjab	.139	.091	.185	.151	29.0	.20
Rajasthan	.172[c]	.111	.250	.196	30.1	.20
Tamil Nadu	.154	.094	.228	.196	30.3	.48[d]
Uttar Pradesh	.238	.158	.352	.249	30.8	.14
West Bengal	.108[c]	.105	.175	.136	36.4	.46
All-India (all religions)	.163[e]	.112[e]	.241	.182	33.3	.25[e]

[a] Based on q(3) and q(5).

[b] Based on q(2) and q(5).

[c] Based on q(2) and q(5).

[d] Relates to 1964.

[e] Pooled estimate for above 15 [illegible]

Source: Computed from India, Registrar General (1975a, 1976b, 1977a); India, National Sample Survey Organisation (1975); and India, Director General of Health Services (1972, 1976); United Nations (1983).

As a second test of the CEB/CS data, state-specific estimates of child mortality were compared with respective socioeconomic levels and with independently computed adult mortality levels. More specifically, two ordinary least-squares regressions were computed, one with q(2) regressed on female literacy (15 years and over) and per capita income as explanatory variables, and the other with preliminary intercensal estimates of life expectancy at age 5 (e_5) as the regressor. The residuals from these two regressions were examined for identifying outliers. For convenience a decadal estimate of child mortality was used as the dependent variable, which was computed by giving a weight of 5/7 to the graduated q(2) estimate from the 1972 Fertility Survey and a weight of 2/7 to the estimate from the 1965-66 NSS.[10] The estimated equations along with the standard errors of the coefficients are given below.

$$(1)\ 1000q(2) = 260.86 - \underset{(0.7194)}{2.0143}\ \text{FLIT} - \underset{(0.1220)}{0.1934}\ \text{INC} \quad (R^2=0.54)$$

$$(2)\ 1000q(2) = 675.73 - \underset{(3.2325)}{9.2352}\ e_5 \qquad (R^2=0.39)$$

The unstandardized residuals from the above regressions are shown in columns 5 and 6 of Table 14. There is a high degree of correspondence among the residuals from the two regressions--the correlation coefficient between the two series is 0.70. Both comparisons indicate that the child mortality estimates are relatively low in the states of Bihar, Haryana, Karnataka, and West Bengal, and they are relatively high in Uttar Pradesh and Gujarat. The evidence from the two residual analyses is slightly contradictory in the case of Maharashtra, Rajasthan, Madhya Pradesh, and Tamil Nadu.

It is noteworthy that a strong geographical pattern is observed in the residuals of the child/adult mortality regression. All southern states, including Maharashtra, have relatively low child mortality estimates compared with their adult mortality levels; all central and northwestern states with the sole exception of Haryana have relatively high child mortality estimates compared with their adult mortality levels. This tendency, while boosting our confidence in the decadal estimates of mortality, reduces to some extent the significance of the individual residuals from the adult mortality regression in detecting errors in child mortality estimates.

TABLE 14 Regression Analyses of State-Specific Estimates of Child Mortality for Identifying Outliers: Selected States of India

State	Graduated q(2) Values	Female Literacy (15 years and above)	Per Capita Income in Rupees at 1960-61 Prices	Life Expectancy at Age 5 (e_5)	Residuals from Regression $(q(2)-\hat{q}(2))$	
	About 1966	1961-71	1961-71	1961-71	Model 1	Model 2
	(1)	(2)	(3)	(4)	(5)	(6)
Andhra Pradesh	.176	14.0	290	52.9	-.001	-.011
Assam	.157	19.0	341	55.2	.000	-.009
Bihar	.160	7.8	211	54.3	-.044	-.014
Gujarat	.166	23.3	391	56.3	+.028	+.010
Haryana	.128	12.6	364	58.3	-.037	-.009
Karnataka	.144	17.5	322	53.7	-.019	-.036
Kerala	.099	15.7	273	60.7	-.005	-.016
Madhya Pradesh	.197	8.8	247	54.0	+.002	+.020
Maharashtra	.153	21.7	408	55.8	+.015	-.007
Orissa	.202	10.9	250	51.6	+.011	+.003
Punjab	.138	20.1	407	60.3	-.004	+.019
Rajasthan	.186	7.3	284	56.3	-.005	+.030
Tamil Nadu	.160	21.2	330	53.9	+.006	-.018
Uttar Pradesh	.262	8.9	250	53.7	+.067	+.082
West Bengal	.127	22.1	389	54.7	-.014	-.044

Notes and Sources:

Column 1: Weights of 2/7 for the estimates from the 1965-66 NSS and 5/7 for those from the 1972 Fertility Survey were employed.

Column 2: Computed from India, Registrar General (1965, 1977a); mean of 1961 and 1971 values.

Column 3: India, Reserve Bank (1978) and India, Kerala, Bureau of Economics and Statistics (1977). Since the base years for Assam and Karnataka were other than 1960-61, an ad hoc adjustment was made by multiplying the net domestic product at constant prices by the GNP deflator for 1960-61.

Column 4: Dyson (1979b). Estimates are based on the South model mortality pattern; male and female e_5 values were combined using the respective populations as weights.

Finally, we present in Tables 15 and 16 estimates of child mortality from independent sources in the states for which they are available. Table 15 shows the results of Census Fertility Inquiries converted into mortality estimates. These are valuable for showing in every state for which estimates are available that child mortality is estimated to be higher than in the 1965-66 NSS. If the NSS estimates were higher than those in the earlier Census Fertility Inquiries, there would be grounds for serious doubt about the NSS validity, but this proves not to be the case.

2.1.3 Child Mortality Estimates State by State

We now proceed to a state-by-state discussion and synthesis of the data and checks with the aim of arriving at final estimates. We focus on the 1972 Fertility Survey results because they are more suspect, because they are more critical to intercensal analysis since they are "dated" closer to midcensus, and because there are more independent sources for evaluating them.

2.1.3.1 Andhra Pradesh

The 1972 Fertility Survey child mortality estimate for Andhra Pradesh is considered to be low for two reasons: slightly higher q(2)s based on the SRS rates for 1974-76 and the fact that, compared with the estimated adult mortality level, the child mortality estimates appear to be low. Andhra Pradesh being a southern state, however, the latter may simply reflect actual variation in the adult/child mortality relationship. A small increase in SRS infant and child mortality indices by itself is not a compelling reason to assume that the estimate from the 1972 Fertility Survey is low, since the increases could be real. We therefore accept the estimate from this survey without any correction. We have little evidence to doubt the estimate from the 1965-66 NSS and therefore accept it without correction.

2.1.3.2 Assam

The 1972 Fertility Survey estimate for Assam is lower than the corresponding estimate from the 1970-72 SRS, but the SRS figures are also higher than the graduated q(2) value from the 1965-66 NSS. None of the other consistency checks suggests that the possibility of underestimation of child mortality in the two surveys is likely. And as we show below, Assam is the only state for which tests of death registration completeness in the SRS clearly suggest overregistration. Therefore, we accept the child mortality estimates from the two surveys without any adjustment.

2.1.3.3 Bihar

For Bihar the regression analyses strongly suggest the possibility of underestimation of mortality in the 1972 Fertility Survey. The difference between the rural and urban estimates of this survey is quite large, but, as pointed out earlier, there is a strong possibility that the survey has underestimated child mortality in both rural and urban areas. A close agreement is found, however, between the estimates of child mortality derived from the 1972 Fertility Survey and those computed directly from the SRS. On the other hand, there is compelling evidence (and agreement by the Registrar General's office) that the SRS figures for this state for the early 1970s reflect serious underregistration of deaths. Overall we consider the evidence as sufficiently overwhelming to justify discarding the child mortality estimate from the 1972 Fertility Survey. A new estimate is computed by assuming that the pace of the child mortality decline in Bihar was the same as that of all-India and by accepting the estimate from the 1965-66 NSS without any correction. It is possible, however, that the figure from the 1965-66 NSS for the state is also an underestimate.

2.1.3.4 Gujarat

The indications from consistency checks are contradictory in the case of Gujarat. The graduated q(2) value computed from the 1972 Fertility Survey and the 1965-66 NSS is lower than the q(2) value estimated from the SRS infant mortality rate of 1970-72; and the infant mortality rate has shown a tendency to increase, suggesting that its 1970-72 level was itself an underestimate. The possibility of underestimation of child mortality in the 1965-66 NSS is reinforced by the negligible rural-urban differential observed in the child mortality estimates of this

TABLE 15 Child Mortality Estimates Derived from Census Fertility Inquiries Using South Model Variant Regression Coefficients: Selected States and Areas of India

	Geographical Coverage	Estimates of						
		$P_{(1)}/P_{(2)}$ a	$P_{(2)}/P_{(3)}$ a	q(2)	q(3)	q(5)	q(10)	Graduated q(2)
Assam								
1941 Census	Gauhati subdivision except Gauhati Thana (Hindus only)	.1997	.5531	.298	.325	.362	.398	.297
Delhi								
1941 Census	Former Delhi province	.2049	.5809	.313	.298	.338	.372	.286
Jammu and Kashmir								
1941 Census	Jammu and Ladakh districts	.2137	.5421	.285	.244	.345	.309	.261
Karnataka								
1941 Census	Former Princely State of Mysore	.2439	.5577	.249	.262	.288	.340	.239
Kerala								
1941 Census	Travancore State (Caste groups with population less than 50,000 excluded)	.1383	.4750	.168	.165	.173	.216	.150
1951 Census	Travancore-Cochin (10-percent sample)	.1092	.4559	.204	.220	.235	.258	.196

Madhya Pradesh								
1921 Census[b]	Former central provinces and Berar	.4518	.6275	n.a.	.279	.326	.338	.259
1951 Census	Former state of Madhya Pradesh	.2196	.5776	.356	.362	.397	.423	.339
Punjab								
1921 Census[b]	Former province of Punjab	.3461	.6408	.247	.226	.231	.260	.193
Rajasthan[c]								
1941 Census	Ajmer-Merwara and about 13 princely states of Rajaputana (3 major caste groups)	.3342	.6399	.335	.334	.352	.388	.309
West Bengal								
Census Pilot Study, 1951	Rural areas of seven districts	.2839	.5767	.242	.264	.269	.304	.232

Note: n.a. = data not available for making the requisite computations.

[a] Assumptions made in computing average parities for all women in each age/duration category were too elaborate to be discussed here. The procedures varied depending on the data availability.

[b] Data tabulated by duration of marriage (effective); others tabulated by age.

[c] CEB/CS data not classified by age intervals of 17-21, 22-26, etc.

Source: Provincial/state volumes of the census of India for the dates indicated.

TABLE 16 Estimates of Child Mortality Derived from CEB/CS Data of Selected Demographic Sample Surveys: Selected Areas of India

	Area Covered[a]	Date of Survey	Sample Women	q(2)	q(3)	q(5)	q(10)	Graduation q(2)
Karnataka								
Mysore Population Study	Bangalore division and parts of Hassan and Mysore districts	1951-52	14,284[b]	.253	n.a.	.293	n.a.	.246
Bangalore Population Study	Bangalore division	1975	4,722[b]	.136	n.a.	.195	n.a.	.145
Tamil Nadu								
Tamil Nadu Family Planning and Fertility Survey	Entire state	1971-72	5,435[c]	.156	.191	.211	.243	.164
Uttar Pradesh								
Banaras Survey	Rural areas of Banaras tehsil	1956	1,633[d]	.301	.296	.370	.384	.291
Rural U.P. Survey	Rural areas of the state	1956	1,336[c]	.351	.305	n.a.	n.a.	.311
Gorakhpur Region Survey	Rural areas of Gorakhpur division	1969-71	1,296[c]	.248	.288	.335	.337	.260

Note: In converting average parities of married women into average parities of all women, it was assumed that widowed, divorced, and separated women had same parity as married women; child bearing is restricted to married and widowed women only; and marital status distribution can be approximated by the census figures.

[a] A division refers to a group of districts, while a tehsil is an administrative subunit within the district.

[b] Ever-married women.

[c] Currently married women.

[d] Women in unbroken marriage unions.

Sources: Computed from United Nations (1961); Srinivasan et al. (1977); Mukherjee (1975); Rele (1963); Saxena (1962); Saksena and Rastogi (1975).

survey. Contrary to the above, however, the regression analyses show that the decadal estimate of child mortality in this state is relatively high compared with its socioeconomic level and its adult mortality level. In the presence of these conflicting reports, we decided to leave the estimates untouched. Additional data are needed to make a more definitive estimate.

2.1.3.5 Haryana

There is strong evidence indicating that the child mortality estimate from the 1972 Fertility Survey for Haryana is an underestimate. Although the estimate from this survey conforms with the SRS rates of 1970-72, figures for later years from the SRS indicate the possibility that the early figures were underestimates. Unusually small rural-urban differentials in the 1972 survey estimates are in keeping with that possibility. In addition, the q(2) value predicted from the state literacy and income levels turns out to be significantly higher than the decadal estimate derived from the CEB/CS data. The residual error from the adult mortality regression for this state is negative, but all other northern states have a positive deviation. Thus the case for the underestimation of child mortality in the 1972 Fertility Survey is persuasive, but the best we could do in the absence of independent data is to replace the estimate from this survey with the average of the q(2) estimates derived from the infant mortality rate and the ${}_5M_0$ value from the 1974-76 SRS.

2.1.3.6 Karnataka

The child mortality estimate for Karnataka is relatively low compared with the female literacy and income levels. In addition, a large negative residual error from the adult mortality regression cannot be wholly attributed to regional variation in the adult-child relationship. But the 1972 Fertility Survey estimate for this state compares well with the rates from the 1970-72 SRS. Comparison of the 1970-72 and the 1974-76 figures does not imply any improvement in the completeness of the SRS. The computation of rural and urban figures from the 1972 Fertility Survey also shows normal patterns. Fortunately, however, some independent data exist for the state that support the possibility of underestimation of child mortality in the 1972 Fertility Survey. The Bangalore Population Study conducted in 1975 provides an estimate of q(2) (graduated) of 0.145, which is considerably higher than the 1972 Fertility Survey estimate (see Table 15). Although the Bangalore Population Study did not cover the entire state of Karnataka, it is unlikely that the child mortality rate in the study area was higher than in other parts of the state. The child mortality estimate from the 1972 Fertility Survey was therefore replaced by an estimate computed in the following way: Average annual decline in child mortality was calculated from the estimates of q(2) derived from the Bangalore Population Study and the Mysore Population Study conducted in the same region (see Table 16). This rate was applied to the graduated q(2) value from the 1965-66 NSS to produce an estimate for 1968, the reference date of graduated q(2) values from the 1972 Fertility Survey.

2.1.3.7 Kerala

There is little reason to doubt the child mortality estimate derived from the CEB/CS data for Kerala. A small negative residual error from the e_5 regression may be the result of genuine variation in the adult/child mortality relationship. However, the estimate derived from the 1965-66 NSS could be slightly biased upward, since it relates to Hindus only. This is the only state for which within-survey variation in q(x) strongly suggests a mortality decline.

2.1.3.8 Madhya Pradesh

The estimates from the CEB/CS data for Madhya Pradesh do not seem to need a significant correction. The fairly high child mortality estimate relative to the estimated adult mortality level is explainable from the hypothesized regional variation in the adult/child mortality relationship. The 1951 census results are substantially higher than those for 1965-66.

2.1.3.9 Maharashtra

The comparison of the estimates from the 1965-66 NSS and the 1972 Fertility Survey for Maharashtra indicates one of the largest reductions in child mortality, even though the q(x) values of the 1972 Fertility Survey did not show signs of a large reduction. We observe that none of the consistency checks suggests that the underestimation of child mortality in the 1972 Fertility Survey is likely. However, a relatively high decadal q(2) estimate compared with literacy and income levels points to the possibility of overestimation of child mortality in the 1965-66 NSS. While this inference is not inconsistent with the findings of other diagnostic tests, there is no independent source from which to make an alternate estimate of q(2). Therefore, with some hesitation, we accept the estimate from the 1965-66 NSS without adjustment.

2.1.3.10 Orissa

Evidence for Orissa is inconclusive. As in Maharashtra, a positive residual from the regression with two socioeconomic variables suggests the possibility of an overestimation of mortality in the 1965-66 NSS. But as observed earlier, the relatively small rural-urban differential in the estimates of this survey points to the possible underestimation of mortality in rural areas. Since the suggested margin of error is relatively small, we decided to leave the estimates unaltered.

2.1.3.11 Punjab

For Punjab the estimate from the 1972 Fertility Survey falls short of those derived from the 1970-72 SRS. As none of the other consistency checks supports the possibility of an underestimation of child mortality in the 1972 Fertility Survey, we have accepted the estimate. However, the estimate from the 1965-66 NSS could be slightly inaccurate since it refers to Hindus only. Unlike the Kerala estimate, the direction of the bias in this case cannot be predicted. Although the non-Hindus may have lower child mortality, a higher fraction of Hindus are urban dwellers in this state.

2.1.3.12 Rajasthan

The child mortality estimate from the 1972 Fertility Survey for Rajasthan is slightly lower than those computed from the 1970-72 SRS. It is also possible that the infant and child mortality indices of the 1970-72 SRS were themselves underestimated. But the decadal estimate of q(2) seems to be about right. Although its value is relatively high compared with the e_5 estimate, this could be explained by regional patterns in the adult/child mortality relationship. A possibility that is not altogether inconsistent with the findings of the diagnostic tests is that while the 1965-66 NSS has overestimated child mortality in this state, the 1972 Fertility Survey has underestimated it. Since there is little independent evidence to support this claim, no correction was deemed necessary for the estimates derived from the CEB/CS data.

2.1.3.13 Tamil Nadu

The child mortality estimate derived from the 1972 Fertility Survey for Tamil Nadu is considerably lower than that computed from the 1970-72 SRS. The residual from the e_5 regression is also negative, which, is at least partly explained by the possible regional variation in the adult/child mortality relationship. Fortunately, in Tamil Nadu we can also make an independent estimate of child mortality. The CEB/CS data from a statewide survey conducted in 1971-72 produces a graduated q(2) value of 0.165, compared with the value of 0.136 from the 1972 Fertility Survey (see Table 16). As the former is more comparable to the estimates derived from the 1970-72 SRS, we decided to accept it in place of the latter.

2.1.3.14 Uttar Pradesh

The estimates of child mortality for Uttar Pradesh are most intriguing. Very large positive residuals from regression analyses suggest the possibility that we have overestimated child mortality. Since the 1972 Fertility Survey estimate is lower than the corresponding estimates from the 1970-72 SRS, it seems unlikely that the 1972 survey has overestimated child mortality. However, there is weak confirmation for the possible overestimation of mortality in the 1965-66 NSS from the results of two surveys conducted in the mid-1950s in a few rural areas of Uttar Pradesh (see Table 15). According to these two surveys, the level of q(2) in rural Uttar Pradesh was in the neighborhood of 0.300 in the early 1950s, while the corresponding estimate from the NSS is about 0.350 in the early 1960s.

Unfortunately, the sample size and the geographical area covered in the earlier surveys are not large enough to warrant the rejection of the estimate from the 1965-66 NSS. Also to be noted is that, even if a correction is applied to the estimate of child mortality from the 1965-66 NSS, the residuals from the regressions will not significantly diminish unless a much lower value is also assumed for the 1972 Fertility Survey. The evidence from the SRS and an independent source (see Table 15) is much too strong to consider the 1972 Fertility Survey estimate for this state high.

2.1.3.15 West Bengal

The evidence seems to be sufficient to reject the 1972 Fertility Survey estimate for West Bengal. The child mortality estimate from this survey is lower than those computed from the 1970 SRS. Moreover, the early figures from the SRS for this state were themselves underestimates (see Section 2.2). Large negative residuals from regression analyses and the small rural-urban difference in estimated child mortality also suggest underestimation in the 1972 Fertility Survey. The much higher 1965-66 NSS figure is still much lower than those of the 1951 Census Inquiry. In the absence of an independent data source, we accepted the q(2) estimate corresponding to the infant mortality rate of the 1970 SRS.

Since the SRS-based estimates for Bihar and West Bengal are suspect, Table 9 provides the most reliable basis for judging the effect of eliminating Bihar and West Bengal from the all-India estimates of child mortality. Bihar, with a population of 56.4 million in 1971, has a graduated q(2) of .241 (.010 above all-India); West Bengal, with a population of 44.3 million of India's 548.1 million, has a graduated q(2) of .164. Thus excluding the Bihar and West Bengal figures raises the graduated q(2) (Hindus only) for all-India from the .231 shown in Table 9 to .236--some 2 percent.

2.1.4 Summary

Our final estimates of child mortality appear in Table 17. In only 5 of 15 states did we find the evidence

TABLE 17 Final Estimates of q(2): Selected States and All-India

State	About 1961	About 1968	Mid-Decade
Andhra Pradesh	.227	.155	.176
Assam	.161	.155	.157
Bihar	.241	.169[a]	.190
Gujarat	.175	.163	.166
Haryana	.197	.150[a]	.163
Karnataka	.206	.134[a]	.155
Kerala	.135	.084	.099
Madhya Pradesh	.256	.173	.197
Maharashtra	.219	.126	.153
Orissa	.236	.188	.202
Punjab	.168	.126	.138
Rajasthan	.242	.164	.186
Tamil Nadu	.220	.164[a]	.180
Uttar Pradesh	.341	.230	.262
West Bengal	.167	.131[a]	.141
All-India	.225 (.234[b])	.164[c]	.184[c]

[a] Adjusted estimates; see text for explanation.
[b] Hindus only.
[c] State estimates weighted by states population.

sufficiently strong for rejecting the estimates derived from the CEB/CS data in 1972. The five states for which alternate values were assumed were among the 8 states for which comparison of the 1965-66 NSS and the 1972 Fertility Survey indicated a decline of child mortality of one-third or more. At the all-India level, assuming alternate values for 5 states did not substantially reduce the magnitude of the implicit decline in child mortality during the 1960s. While the unadjusted values implied a decline of 32 percent in child mortality, the new values imply a 27-percent reduction in 7 years, an annual rate of decline of 3.8 percent. The graduated q(2) of .125 for 1979 thus implies that a decline of 24 percent occurred over the subsequent seven-year period, so that the pace of decline appears relatively constant. However, the decline may be overestimated for the latter period because we have been able to adjust (upward) the earlier estimate but not the later one.

For similar reasons the regional pattern of results may be somewhat less accurate after the adjustments than before. Because of the availability of independent survey information in several states (especially Karnataka and Tamil Nadu), we have been able to adjust their 1972 Fertility Survey estimates. Had similar information been available for other states, it may have produced similar adjustments. Nevertheless, a distinct regional patterning, particularly a north/south distinction, appears in both our adjusted and unadjusted results.

We referred earlier to the discrepancy between the strong implied decline in child mortality from the 1965-66 to the 1972 survey and the absence of apparent decline when one survey is examined in isolation. Since we have concluded that a very sizable decline did in fact occur, the most likely explanation of the discrepancy is that older women are omitting a higher fraction of dead children. That older women are omitting a higher fraction of children ever born is also suggested in Section 2.3, and it seems reasonable to expect that dead children are the most frequently omitted.

2.2 MORTALITY AT OTHER AGES AND ALL AGES

From its inception the Sample Registration System has generated data on deaths by age and on the population at risk of death. These are processed into crude death rates, which have appeared irregularly in Bulletins. Table 18 presents the SRS crude death rates by state through 1979, and Table 19 presents certain functions in life tables based on age-specific data for all-India, exclusive of Bihar and West Bengal.[11]

The major issue in interpreting the figures in Tables 18 and 19 is, of course, the accuracy and completeness of the SRS mortality data. The accuracy of the age data in the SRS is probably somewhat better than average for Indian data because the households involved have usually been visited for several years. Age heaping in the quinquennial age distribution of SRS households is not as severe as that in Indian censuses. It is also useful to note that age at death is determined by reference to the decedent's age at the time of the last visit to his or her household, rather than from a declaration by a living relative. Therefore, age-specific death rates should not

TABLE 18 Unadjusted Crude Death Rates from the Sample Registration System: Selected States and All-India

State	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1979[a]
Andhra Pradesh	15.8	14.6	16.1	16.6	15.2	15.2	14.5	14.2	13.3	12.8	12.6
Assam	16.2	17.8	17.9	16.4	16.8	16.9	14.9	12.9	13.2	11.4	11.2
Bihar	14.1	14.2	18.3	14.7	15.9	13.3	12.1	12.1	13.3	13.0	15.1
Gujarat	17.4	16.4	14.9	15.8	13.0	15.4	15.3	14.8	12.7	13.1	12.9
Haryana	9.4	9.9	11.7	12.1	12.6	12.3	12.8	13.7	13.5	10.6	10.5
Karnataka	13.1	12.1	12.8	12.4	10.8	11.1	11.7	11.1	12.0	10.4	10.4
Kerala	9.2	9.0	9.2	8.5	7.8	8.4	8.1	7.3	7.0	6.8	6.9
Madhya Pradesh	16.4	15.6	18.7	16.9	15.8	18.5	16.5	17.9	15.1	15.1	15.3
Maharashtra	11.9	12.3	12.8	13.6	11.5	11.4	11.3	12.8	10.3	10.9	10.7
Orissa	16.4	15.5	20.0	18.2	15.8	17.7	15.8	16.6	14.1	15.0	14.8
Punjab	11.2	10.3	12.6	12.1	10.6	10.8	11.0	10.8	11.6	9.9	9.5
Rajasthan	17.6	15.6	16.8	16.1	14.3	15.9	14.7	14.8	15.6	12.8	12.8
Tamil Nadu	15.6	14.4	15.1	14.1	13.9	15.0	14.6	13.7	12.8	12.1	12.1
Uttar Pradesh	21.6	20.1	25.6	19.4	19.7	22.6	20.5	19.1	20.2	16.2	16.2
West Bengal	10.6	--	--	--	12.4	13.0	11.9	11.7	11.6	--	21.1
All-India	15.7										13.0
All-India (except Bihar and West Bengal)	16.0[b]	15.2[b]	16.9	15.5	14.5	15.9	15.0	14.7	14.2	12.8	12.8

[a] "Pooled" estimates incorporating new SRS areas. Figures for Bihar and West Bengal refer only to new areas.

[b] State-weighted.

Sources: India, Registrar General, Sample Registration Bulletins: Vol. XV(1), June 1981; Vol. XIII(1), June 1979; Vol. XII(1), June 1978; Vol. XI(1), January 1977; Vol. IX(1), January 1975.

be affected by differential age misreporting between numerator and denominator. The most likely effect of age misreporting on age-specific mortality is a spurious inflation of death rates at ages 0-4 because the tendency to round age upward would deprive this age group of its lowest-mortality segment. This tendency would be strongest in the earlier stages of SRS operation, since age in SRS semiannual interviews is determined by adding 6 months to the age previously recorded. The situation is less straightforward with regard to the elderly. Age-specific data from the SRS show much more rapid increases with age in age-specific death rates beyond ages 40-44 than is contained in any of the Coale-Demeny model life tables at comparable mortality levels. The intercensal age check summarized in Table 4 (Chapter 1) raises the possibility that this pattern is spurious, caused by net age understatement, contrary to normal patterns expected at older ages.

Even more important for mortality estimation than the accuracy of age data is the completeness of the recording of deaths. We have reviewed several direct investigations of completeness in Chapter 1; they tended to cluster in a range of around 95 percent. There are also indirect tests of registration completeness that can be applied to the SRS data. These tests compare certain demographic features of the population--particularly its age structure and growth rate--to recorded numbers of deaths. We have principally relied on two methods. One is the Brass (1975) method, which basically compares the slope of the age distribution with that implied by recorded mortality conditions and by an inferred growth rate assumed to be constant at each age. Given a certain growth rate, a steeper age distribution should be associated with higher mortality. If the steepness exceeds that implied by registered deaths, then deaths are assumed to be underreported. The second method, that of Preston and Coale (Preston et al., 1980), basically compares the number of persons above a certain age to the number implied by registered deaths together with an assumed constant growth rate above that age. The starting and terminal ages for applying the techniques can be varied, and different completeness levels are associated with different combinations.

Table 20 shows the results of applying these two methods to all-India data, exclusive of Bihar and West Bengal, for which data are not available. For the Brass procedure, data for three different age ranges were used

TABLE 19 Age-Specific Death Rates and Certain Life Table Functions Computed for Unadjusted SRS Data: All-India[a]

	1971			1972-73			1976		
Age	M(x)	l(x)	E(x)	M(x)	l(x)	E(x)	M(x)	l(x)	E(x)
Males									
0	.14282	100000	50.193	.14650	100000	48.927	.13671	100000	49.118
1	.02337	87100	56.589	.02460	86800	55.329	.02547	87600	55.036
5	.00450	79450	57.918	.00490	78799	56.820	.00430	79259	56.696
10	.00210	77682	54.179	.00210	76892	53.168	.00240	77573	52.874
15	.00190	76871	49.725	.00230	76089	48.702	.00250	76648	48.482
20	.00300	76144	45.176	.00290	75219	44.237	.00270	75696	44.061
25	.00300	75010	40.821	.00315	74136	39.846	.00310	74681	39.626
30	.00390	73893	36.400	.00430	72977	35.439	.00420	73532	35.206
35	.00550	72466	32.067	.00535	71425	31.155	.00450	72004	30.900
40	.00740	70500	27.892	.00810	69539	26.932	.00950	70402	26.546
45	.01050	67939	23.849	.01210	66779	22.942	.01210	67135	22.716
50	.01900	64464	20.000	.01815	62857	19.218	.01950	63193	18.977
55	.02460	58617	16.745	.02675	57401	15.807	.02860	57318	15.666
60	.03700	51825	13.612	.04295	50205	12.714	.04840	49668	12.694
65	.05380	43049	10.878	.05885	40469	10.172	.05760	38946	10.500
70	.11030	32842	8.482	.12060	30088	7.818	.11460	29141	8.192

Females

0	.14282	100000	49.356	.15830	100000	47.108	.15021	100000	50.965
1	.03009	87100	55.629	.03077	85850	53.831	.02463	86500	57.881
5	.00490	77417	58.430	.00550	76107	56.563	.00510	78517	59.638
10	.00210	75543	54.817	.00250	74043	53.070	.00250	76540	56.114
15	.00300	74754	50.370	.00345	73123	48.706	.00290	75590	51.788
20	.00430	73641	46.093	.00495	71872	44.510	.00410	74501	47.508
25	.00430	72075	42.041	.00490	70115	40.563	.00460	72990	43.440
30	.00520	70542	37.900	.00595	68418	36.507	.00480	71330	39.393
35	.00600	68731	33.832	.00580	66412	32.534	.00500	69638	35.289
40	.00600	66700	29.787	.00705	64514	28.418	.00470	67919	31.119
45	.00850	64728	25.618	.00945	62279	24.348	.00800	66341	26.800
50	.01430	62034	21.622	.01440	59404	20.405	.01260	63740	22.792
55	.01750	57752	18.040	.02150	55276	16.743	.01850	59847	19.112
60	.03270	52911	14.462	.03680	49637	13.361	.03340	54556	15.723
65	.04290	44913	11.591	.05525	41273	10.562	.04640	46147	13.132
70	.10850	36213	8.776	.11750	31255	8.146	.08550	36554	10.922

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[a] Excludes Bihar and West Bengal.

TABLE 20 Results of Applying Techniques for Estimating Death Registration Completeness to the SRS Data: All-India

Brass Estimates of Registration Completeness[b]								
	Male				Female			
Age Range Used For Fitting	1971	1972-73	1976	Mean	1971	1972-73	1976	Mean
5-65	.824 (.0213)	.924 (.0222)	.960 (.0225)	.902 (.0220)	.826 (.0232)	.945 (.0236)	.775 (.0225)	.849 (.0231)
15-55	.763 (.0186)	.863 (.0199)	.880 (.0208)	.835 (.0198)	.794 (.0220)	.896 (.0222)	.734 (.0216)	.808 (.0219)
5-55	.825 (.0214)	.941 (.0227)	.935 (.0225)	.900 (.0222)	.797 (.0223)	.911 (.0227)	.742 (.0216)	.816 (.0216)
Mean of 9				.879 (.0213)				.824 (.0224)
Preston-Coale Estimates of Regression Completeness Based on Ages 0+ to 70+								
Growth Rate Used								
.021	.851	.915	.927	.898	.804	.893	.753	.817
.022	.888	.953	.966	.936	.838	.930	.784	.851
.023	.926	.994	1.007	.976	.874	.970	.817	.887
Mean of 9				.936				.851

[a] Excludes Bihar and West Bengal.
[b] Implied growth rate in parentheses.

for fitting purposes. The maximum range allowed by the data is 5-65. However, the clustering of points shows a departure from a straight line of the point corresponding to the highest age; the age range of 5-55 is probably most satisfactory, in view of the age misreporting problems in the teenage years described above. The Brass results show a range of about 7 points of completeness, depending on the fitting ages chosen, with the preferred age range giving intermediate results. The implied growth rates are highly satisfactory. The mean of the nine growth rates for females is .0224, which is exactly the recorded intercensal growth rate for females during 1971-81. For males the mean implied growth rate is .0213, compared with an intercensal rate of .0218. The consistency of these rates adds validity to the results of applying the method.

Table 20 also shows completeness estimates derived from the Preston-Coale procedure for growth rates in the range of .021 to .023. The results are quite sensitive to the growth rate chosen, but the range of estimates is rather consistent with that of Brass. The interpolated mean value at an r of .0224 for females is .865, and at an r of .0218 for males it is .928. These are about 5 points and 3 points higher, respectively, than the Brass results for the age range 5-55. A reasonable explanation of the relatively small difference is that the Brass results are somewhat more biased in a downward direction by declining mortality (Preston, et al., 1980), which has certainly occurred in India. However, the decline has not produced a set of age-specific growth rates that differ so sharply from constancy, at least during 1961-71, that the procedures would give seriously misleading results (say, by as much as 15 points). At the same time, the Preston-Coale results are biased upward by age overstatement more than Brass's (Preston, et al., 1980). This could also explain the small discrepancy between the two sets of results, although, as noted above, it is not clear that age overstatement is a more serious problem in India than age understatement. Leaning toward the former explanation of the discrepancy, we adopt .87 for females and .93 for males as our best estimate of death registration completeness during the first half of the 1970s in the SRS. The very wide range of estimates presented in Table 20, however, precludes a great deal of confidence being attached to these figures. An additional test of their adequacy is performed in the simulations presented in the final chapter.

Both the Brass and the Preston-Coale results imply more complete male than female death registration. Differences tend to be on the order of 3 points for the age range 5-55 (Brass), or an r of .022 (Preston-Coale), except in the 1976 data, for which it is about 19 points. Completeness for females in 1976 is estimated to be unusually low. This results not from an unusually low crude death rate for females but from unusually low rates at ages over 65, a feature that also appears to some extent in 1977 age-specific data (India, Registrar General, 1980b). Female registration in 1972-73 does appear to be quite high relative to that of other years. Ignoring the 1972-73 estimates, both the Brass and Preston-Coale results show a deterioration of 6 points in completeness for females between 1971 and 1976 and an improvement of 8-11 points for males. The disparate trends for males and females are implausible. We are inclined to ascribe the year-to-year fluctuations to actual fluctuations in mortality, which apparently remain considerable in India. Were we able to observe actual yearly growth rates in the Preston-Coale technique, rather than annual averages over an intercensal period, the completeness estimates would probably be less variable. The high 1972-73 completeness estimates, for example, may reflect the serious harvest problems of the 1972-73 period, when food grain consumption per capita declined by 9 percent from its value during 1971-72 (World Bank, 1978). While our yearly estimates of completeness are probably contaminated by yearly deviation of the data from our assumptions, there is no reason to think that the average of yearly estimates is biased by such problems. We conclude that the completeness of death registration in the SRS during the period 1971-76 was about 90 percent, was about 6 points higher for males than for females, and was not exhibiting a clear-cut trend during the period.

Extensive work was also undertaken by the panel to investigate the completeness of the SRS death registration by state. An initial study, using mainly the Brass and Preston-Coale procedures, concluded that death registration completeness in 1969-71 and 1970-72 seemed conclusively to be below the all-India average only in Bihar and West Bengal (Preston et al., 1979). The Registrar General obviously concurred in this assessment because he stopped including these states in the all-India death rates (and birth rates) in 1972. The suspicion was also confirmed for Bihar for 1979, when results from the new sample areas in the SRS were presented for the first time. Bihar's crude death rate in the new sample area was 15.1, compared with 13.0 in the old (Table 18). Other states showed very minor differences between results for the old area and those based on old and new ones. Death registration completeness in the remaining states did not seem to differ substantially from the all-India average.

Subsequent work has tended to confirm the lack of sharp regional differentiation in completeness of death registration. However, state results are generally too variable over time and by sex, as well as with regard to the method and age range chosen, to allow very firm conclusions to be drawn on this score.[12] Part of the variability results from the small numbers of deaths involved. A quinquennial age group in a state-period combination typically has fewer than 10 deaths, and quite often 1-3. It should also be recognized that a state's estimate of completeness is biased if net immigration or emigration is occurring, a problem not present at the national level.

The mean completeness estimates for states during 1970-71, 1972-74, and 1975-76 using the Brass and Preston-Coale procedures for males and females are shown in Table 21. The years, methods, and sexes are grouped in order to provide maximum robustness and because little validity could be attached to variation in any of these dimensions by state. Table 21 suggests that there is relatively little variation among the states from the all-India average of .90 presented above. No state is as much as 12 points below this average, and of course any estimate of greater than 1.00 is to be credited to error in the data or the assumptions. Furthermore, it should be observed that for no state-sex-method combination for the period did the estimate ever fall below .72, and that each state had one sex-method combination at least as high as .85. Therefore, we find little basis in these results for differentially adjusting the states for incompleteness of death registration.

Estimates of crude birth rates are clearly a by-product of the estimates of death registration completeness. The connection is most immediate for the Preston-Coale procedure, in which the value of the growth rate used as input to the procedure can simply be added to the corrected death rate in order to estimate the crude birth rate. This procedure produces birth rate estimates that are quite insensitive in India to estimates of the growth

TABLE 21 Estimates of SRS Death Registration Completeness, 1970-76: Selected States of India

State	Mean of Completeness Estimates for Males and Females; Using Brass and Preston-Coale Procedures; Applied to 1970-71, 1972-74, and 1975-76
Andhra Pradesh	.90
Assam	1.17
Gujarat	.87
Haryana	.92
Karnataka	.89
Kerala	1.00
Madhya Pradesh	.79
Maharashtra	.82
Orissa	1.00
Punjab	1.04
Rajasthan	.79
Tamil Nadu	.85
Uttar Pradesh	.93

rate, because higher values for r will raise completeness estimates more or less proportionately, and hence reduce the corrected death rate to which it is added (Preston and Hill, 1980). Ironically, as a result of these offsetting tendencies, birth rate estimates are much less sensitive to errors in the assumed growth rate than are death rate estimates.

Table 22 shows all-India estimates of crude birth rates derived in this fashion. Growth rates in the range of 21 to 23 per 1,000 are used because there is good evidence from censuses that the true growth rate falls within this range. Variation of 2 per 1,000 in the input growth rate results in variation in the estimated birth rate of only 0.5 per 1,000. Application of the procedure to results for 1971, 1972-73, and 1976 indicates a very small decline of only about 0.3 per 1,000 in crude birth rates regardless of which input growth rate is chosen. This procedure thus indicates a relatively stable crude birth rate in the range of 39.0-39.5 during the first half of the 1971-81 decade. If completeness estimates were biased by as much as 5 percent (e.g., from declining

TABLE 22 Estimate of Crude Birth Rates Based on SRS Registered Deaths and Estimates of Death Registration Completeness: All-India[a]

Assumed Growth Rate	Estimate of Death Registration Completeness, Age 0+ Based on Preston-Coale Method (mean, male and female)	Recorded Crude Death Rate, SRS (per 1,000)	Implied Crude Birth Rate
(1)	(2)	(3)	(4)=(1)+(3)/(2)
1971			
21/1,000	.827	15.05	39.2
22/1,000	.863	15.05	39.4
23/1,000	.900	15.05	39.7
1972-73			
21/1,000	.904	16.2	38.9
22/1,000	.941	16.2	39.2
23/1,000	.982	16.2	39.5
1976			
21/1,000	.840	15.0	38.9
22/1,000	.875	15.0	39.1
23/1,000	.912	15.0	39.4

Note: Excludes Bihar and West Bengal.

mortality or age misstatement), the estimate of the crude birth rate would be in error by about (15-15/1.05) = 0.7 per 1,000.

The above procedure can also be applied to the data for states. There is greater potential for error in state-specific estimates because of the smaller numbers in the SRS and because states have a greater capacity for violating assumptions, particularly the assumption of a closed population. However, the procedure is one of the very few available for providing estimates of birth rates beyond the 1971 census that is independent of the SRS birth registration. Table 23 shows the results of making state-specific estimates for 1975-76, the latest year for which they are available.[13] Results are quite similar in level and geographic pattern to those made for 1969-71 (Preston et al., 1979). They generally embody the higher

TABLE 23 Crude Birth Rate Estimates in 1975-76 by State, Implied by Estimates of Death Registration Completeness in the SRS: Selected States of India

State	Growth Rate Estimated from Brass Procedure, Ages 5-50 (per 1,000)	Completeness Estimated From Preston-Coale Procedure, Using Growth Rate in (1)	Mean Death Rate 1975-76	Estimated Crude Birth Rate
	(1)	(2)	(3)	(4)=(1)+(3)/(2)
Andhra Pradesh	16.4	.797	14.85	35.1
Assam	26.0	1.082	15.9	40.7
Gujarat	24.15	.834	15.35	42.5
Haryana	26.34	.851	12.55	41.0
Jammu and Kashmir	20.45	.781	12.05	35.9
Karnataka	22.45	.797	11.4	36.7
Kerala	27.05	1.012	8.25	35.2
Madhya Pradesh	18.4	.765	17.5	41.3
Maharashtra	22.15	.834	11.35	35.8
Orissa	17.55	.937	16.75	35.4
Punjab	25.05	.979	10.9	36.2
Rajasthan	22.95	.739	15.3	43.7
Tamil Nadu	17.15	.873	14.8	34.1
Uttar Pradesh	18.7	.894	21.55	42.8

Note: All figures refer to the mean of males and females.

fertility pattern of northern India that appears elsewhere in this report. A more extensive discussion appears in Chapter 2, Section 2.3; here we should caution that net internal migration is influencing the results in unpredictable ways, depending on its direction, age-incidence, and persistence. Generally, net emigration biases upward estimates of birth rates made by the procedure used here, because the inferred growth rate equals the actual crude rate of natural increase plus the crude rate of net emigration. We should stress that the estimates of birth rates in Table 23 are believed to be more robust than estimates of completeness or of death rates, and we caution against acceptance of the completeness estimates at face value.

2.3 FERTILITY

2.3.1 All-India Estimates

There are four major sources of information on fertility in India: intercensal analysis, which is discussed in Chapter 3; SRS tabulations of crude birth rates, general fertility rates, and occasionally age-specific fertility rates; the 1972 Fertility Survey, conducted on SRS sample areas; and the 1979 Child Mortality Survey, also conducted on SRS areas.

Of these systems, the SRS is doubtless the most important because of its continuous generation and timely presentation of data. Table 24 presents crude birth rates from the SRS since 1970. Because of their importance, much of this section focuses on evaluating the quality and particularly the completeness of the SRS data. The main attempts at direct evaluation, summarized above, cover a very small fraction of the SRS experience. The additional tests compare SRS-based rates with those produced by the other sources mentioned. Unfortunately, direct comparisons are not possible with intercensal procedures, since the SRS was only partially functioning during the 1961-71 decade and the 1981 census results are not yet available in the necessary detail.

Needless to say, the 1972 and 1979 surveys are not themselves unimpeachable sources. In fact, each of them is subject to serious problems that reduce their utility. Both surveys asked questions both on number of children born in a woman's lifetime and on births that occurred in the year preceding the survey. These questions allow an

TABLE 24 Unadjusted Crude Birth Rates from the Sample Registration System: Selected States and All-India

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1979[a]
Andhra Pradesh	35.4	34.8	35.8	31.6	34.6	34.9	33.7	32.3	33.6	31.9	32.1
Assam	38.8	38.5	36.4	33.3	32.8	30.1	32.8	30.1	30.8	32.4	33.8
Bihar	32.0	32.8	33.1	31.4	28.7	27.7	31.1	30.1	31.2	32.0	38.4
Gujarat	41.0	40.0	40.2	35.4	38.4	37.0	37.4	36.1	35.8	35.7	34.9
Haryana	36.2	42.1	40.5	39.4	39.5	38.0	36.3	34.6	33.5	36.4	36.6
Karnataka	33.0	31.7	31.5	28.9	28.0	27.7	29.4	26.3	29.2	28.9	28.1
Kerala	31.6	31.1	31.2	29.2	26.8	28.0	27.8	25.8	25.2	26.1	25.8
Madhya Pradesh	39.3	39.1	39.3	37.4	36.6	40.3	39.8	38.3	37.2	37.8	37.8
Maharashtra	31.5	32.2	32.2	28.8	29.0	29.7	29.3	26.2	26.9	27.1	27.2
Orissa	38.1	34.6	34.5	34.8	33.6	33.6	34.8	29.9	32.9	32.4	31.0
Punjab	33.8	34.2	34.6	33.4	32.0	31.8	31.6	31.0	29.4	29.3	28.7
Rajasthan	38.5	42.4	42.4	38.1	36.3	36.9	33.4	33.8	35.5	35.2	35.5
Tamil Nadu	30.0	31.4	32.4	30.0	29.2	30.7	30.7	29.8	28.8	28.1	28.9
Uttar Pradesh	45.4	44.9	43.2	41.7	42.1	43.1	40.0	40.3	40.4	39.6	39.6
West Bengal	27.8	--	--	--	28.0	28.7	31.9	32.1	28.4	--	32.7
All-India (except Bihar and West Bengal)	36.8	36.9	36.6	34.6	34.5	35.2	34.4	33.0	33.3	33.2	33.1
All-India (weighted average including Bihar and West Bengal)	35.9	--	--	--	33.4	33.9	33.8			--	33.7[b]

[a] "Pooled" estimates incorporating new SRS sample areas. Figures for Bihar and West Bengal refer only to new areas.

[b] Direct estimate presented in SRS Bulletin.

Sources: India, Registrar General, Sample Registration Bulletins: Vol. XV(1), June 1981; Vol. XIII(1), June 1979; Vol. XII(1), June 1978; Vol. XI(1), January 1977; Vol. IX(3), July 1975.

evaluation of the consistency of the two results and often suggest adjustment procedures. In the 1979 survey, however, there is reason to suspect that both pieces of information are biased downward, relative to the 1972 survey, so that consistency may give a spurious appearance of accuracy. In particular, as noted above, the cumulative fertility questions were limited to "total children born alive" and "total children surviving," without additional probes asking about children living at home and away and children who have died. Such probes were included in the 1972 survey. With regard to births in the last year, the 1979 survey of SRS households, conducted by the SRS supervisors, did not include births occurring in the past year that were recorded by the enumerator but missed by the supervisor (India, Registrar General, 1980a:20). As a result, the survey crude birth rate for 1978 for all-India (except Bihar and West Bengal) is 32.5, compared with the 33.3 of the SRS itself. There was more contamination of the two sources in the 1972 survey. Births missed by the supervisors but caught by the enumerators were included (Jain and Adlakha, 1982). The Registrar General has also informally indicated that some adjustments were made to the SRS estimates as a result of data becoming available in the 1972 Fertility Survey. These adjustments may account for the fact that the SRS half-yearly crude birth rates for the second half of 1971 and the first half of 1972 (i.e., the period covered by the survey) were the highest ever recorded for all-India in the respective half-yearly series. This contamination clearly reduces the value of the 1972 Fertility Survey as an independent source with which to evaluate the SRS, although it has probably increased the internal quality of the survey data themselves.

The main problem with the 1972 survey is not the manner in which questions were asked but who was asked. The survey was to be administered to a sample of ever-married women, but the marital distribution is out of line with that of the 1971 census. Depending on its source, this discrepancy could seriously affect the interpretation of results from the survey. On the other hand, the comparison of the marital distribution from the 1979 survey with the sample distribution from the 1981 census shows only minor variations.

The disparity between marital distributions in the 1971 census and 1972 survey is shown in Table 25. At all ages below 40 and especially at ages 15-19, the 1972 Fertility Survey has a lower proportion married. Such a

TABLE 25 Female Marital Distributions from the 1971 Census and 1972 Fertility Survey: All-India

	Percent Currently Married	
Age Group	1971 Census[a]	1972 Fertility Survey[b]
15-19	55.4	41.1
20-24	88.4	83.7
25-29	95.0	92.3
30-34	94.1	90.3
35-39	91.4	88.6
40-44	84.2	86.7
45-49	78.2	97.9
10+	64.4	60.6

[a] Source: India, Registrar General (1977a).

[b] Derived by dividing age-specific fertility rates by age-specific marital fertility rates presented in India, Registrar General (1976b). The figure for 10+ was directly available. The anomaly at 45-49 is unexplained; it may result from the allocation of births at 50+ to ages 45-49 in age-specific fertility rates but not in marital fertility rates.

rapid change in behavior is totally implausible and nearly mathematically impossible at ages 15-19. There would seem to be three possible explanations of the difference:

(1) Too few women were administered the 1972 survey instrument in the SRS areas.
  (a) These women were randomly distributed with regard to fertility.
  (b) These were, disproportionately, childless women whom the survey takers believed could be skipped.

(2) A real difference exists in marital distribution (but not necessarily in marital fertility) between the SRS areas and the national average.

Explanations (1a) and (2) imply that marital fertility rates recorded in the 1972 Fertility Survey may be appropriate for all-India, whereas age-specific fertility rates (i.e., those for all women regardless of marital status) would be too low in the SRS. Explanation (1b), which is perhaps most plausible, implies that total fertility rates in the SRS would be roughly correct (the upward bias in marital fertility rates compensating for the downward bias in proportions married), whereas marital fertility rates in the SRS would be too high. The basic point is that marital fertility and total fertility rates in the survey cannot both be correct because they imply a marital distribution that is inconsistent with that of all-India.

Application of a standard procedure for correcting age-specific fertility rates for biases of various sorts indicates that final results are not heavily dependent on which set of fertility rates--age-specific or marital--we initially accept from the 1972 Fertility Survey. The method referred to is the P/F method developed by Brass (Brass and Coale, 1968). It compares the mean reported number of children ever born to women, by age, to the number they would have it they had borne children at the age-specific rates reported in the survey.

We have performed this comparison twice. In the first case (A) we have accepted the age-specific fertility rates of the 1972 Fertility Survey and the marital distribution implied therein (as appropriate for explanation 1b above).[14] In the second case (B, appropriate for explanations 1a and 2), we have accepted the marital fertility rates of the survey together with the proportion married from the census. Note that the respective marital distributions pertain both to the currently married, who are reporting births in the year before the survey, and to the ever-married, who are reporting lifetime births. To select the currently married from one source and the ever-married from the other would imply that the post-married distributions, which are consistent between the sources, are erroneous in both.[15]

Results of the P/F procedure, presented in Table 26, show that, when the marital distibution of the survey is accepted, there is a high degree of consistency between the cumulative parities reported by women in the survey (P) and their reported births in the year preceding the survey (F). Results at ages 15-19 are usually unreliable because childbearing is just beginning; results at high ages become suspect because older women may not report children ever born as completely as younger women,

TABLE 26 Application of the P/F Method to Data from the 1972 Fertility Survey and the 1971 Census: All-India

Age Interval	Mean Parity of All Women P(i)	Births per Woman in Year Preceding Survey f(i)	Births That Would Occur by End of Age Interval According to f(i) Schedule Q(i)	Estimated Mean Births per Woman Based on Q(i)[a] F(i)	P(i)/F(i)
	(1)	(2)	(3)	(4)	(5)
A. Using Marital Distribution of Fertility Survey					
15-19	.1649	.0873	.4365	.1848	.892
20-24	1.2062	.2619	1.7460	1.1858	1.017
25-29	2.6481	.2761	3.1265	2.5905	1.022
30-34	3.7862	.2169	4.2110	3.8085	.994
35-39	4.6003	.1428	4.9250	4.6590	.987
40-44	5.0615	.0755	5.3025	5.1436	.984
45-49	5.0735	.0292	5.4485	5.4144	.937

B. Using Marital Distribution of 1971 Census

15-19	.2218	.1181	.5905	.2604	.852
20-24	1.2794	.2781	1.9810	1.3923	.919
25-29	2.7224	.2842	3.4020	2.8508	.955
30-34	3.9369	.2256	4.5300	4.1123	.957
35-39	4.7320	.1472	5.2660	4.9955	.947
40-44	5.0507	.0731	5.6315	5.4907	.920
45-49	5.0469	.0230	5.7465	5.7196	.882

Note: Rural and urban values of P(i) and F(i) were combined using the 1971 census rural-urban distribution of women by age.

[a] Conversion from Q(i) to F(i) is accomplished by using equations presented in United Nations (1983:Ch. 3).

especially if a child has died or left home. For the key ages of 20-34, the mean value of P/F is 1.011. Multiplying the total fertility rate of 5.4485 implied by reported births last year by this adjustment factor of 1.011 gives a corrected total fertility rate of 5.51 for 1971-72. It is possible, indeed likely, that declining fertility at young ages has biased P/F upward to some extent at ages 20-34, since the cumulative childbearing reflected in P is higher than that in the year preceding the survey, reflected in F. The major point is clearly that reported births in the year preceding the survey show very little need for correction based on cumulative fertility reports.

This consistency disappears, however, when marital fertility rates from the survey and cumulative fertility for ever-married women from this source are applied to the respective marital distributions from the 1971 census. Because the census shows a higher proportion currently married than the survey, but a relatively similar proportion ever-married at higher ages, F is raised more than P and P/F declines. The new total fertility rate becomes 5.75 instead of 5.45 when the survey marital distribution is accepted. This comparison suggests that either P is too low or F is too high. The mean value of P/F at ages 20-34 is .944. If we accept P as the more valid of the two measures at this age, which is the customary assumption, then the corrected total fertility rate is 5.747 (.944) = 5.43. Once again, this figure may be biased upward slightly by declining fertility.

Thus, there is good agreement between the two sets of results of applying the P/F method to the 1972 Fertility Survey data, regardless of whether the marital distribution from the survey or from the census is adopted. The suggested range of the total fertility rate is 5.4 to 5.5 in 1971-72. This figure differs from that of others who have examined the same data set. First, Jain and Adlakha (1982) accept the figure of 5.75 given from case B in Table 26. This choice means that they have discarded the P/F results showing that births in the year preceding the census are too high relative to lifetime births when the census marital distribution is used. Presumably, they believe that P is biased downward. Second, Dyson (1979b) develops estimates in the range of 5.8 to 5.9 by taking the ever-married distribution from the census and accepting the currently married distribution from the survey (that is, he does not adjust the survey marital fertility rates for differences between the census and survey marital distributions). In effect, he draws the Pi values from case B in Table 26 and the Fi values from case A. The ambiguities surrounding the P/F application--marital distributional anomalies, biases from declining fertility, ever-present age misreporting, and other problems--prevent reaching results to which one can attach a high degree of confidence. In the next section we present state-specific results, which clarify certain of the all-India results just reported.

The P/F procedure was also applied to data from a 25-percent sample of the 1979 survey. Two cautionary notes are required at the outset. First, SRS crude birth rates were clearly exhibiting a decline during the 1970s (Table 24), which biases upward the P/F adjustment factor. Second, as noted above, there is reason to suspect, simply from the way that questions were asked, that both P and F may have been too low in the 1979 survey. The results of the P/F procedure presented in Table 27 show that, except for ages 15-19, cumulative parity is much higher than that implied by births in the year preceding the survey. Contrary to the pattern normally observed in developing countries, the P/F ratio increases with age. This age pattern is consistent with a decline in fertility that is concentrated at older ages. The variability and unusual age pattern of P/Fs provides a very weak basis for developing an adjustment factor that could correct the F series for reference period bias or other deficiencies. If we accepted the mean P/F value at ages 20-34 of 1.097, then the implied total fertility rate would be 4.3025 x (1.097) = 4.72.

An alternate test takes advantage of the data available from the 1972 Fertility Survey to examine the validity of the 1979 survey. Suppose that the Pi's recorded in the 1972 survey are accurate and that childbearing between the 1972 and 1979 surveys occurred at the interpolated mean of the age-specific fertility rates recorded in the 1972 and 1979 surveys. We can then estimate what the mean parity of women would be, by age, in 1979.[16] This procedure enables us to discard the assumption of constant fertility that is required in the P/F procedure. In effect, it compares P in 1979 with an F that amalgamates an earlier P with intersurvey fertility.

Table 28 shows the results of this procedure. The predicted value of P is within 2.2 percent of the actual value in the age range 25-49. At the highest age, P is slightly below predictions, presumably because of a failure to report children ever born in the 1979 survey.

TABLE 27 Application of the P/F Method to Fertility Data from the 1979 Infant Mortality Survey: All-India

Age Interval	Mean Parity of all Women P(i)[a]	Births per Woman in Year Preceding Survey f(i)[b]	Births That Would Occur by End of Age Interval According to f(i) Schedule Q(i)	Estimated Births per Woman Based on Q(i)[c] F(i)	P(i)/F(i)
	(1)	(2)	(3)	(4)	(5)
15-19	.1215	.0658	.3290	.1555	0.781
20-24	1.0019	.2277	1.4675	.9806	1.022
25-29	2.4266	.2306	2.6205	2.1817	1.112
30-34	3.6281	.1613	3.4270	3.1361	1.157
35-39	4.4820	.1063	3.9585	3.7676	1.190
40-44	4.8898	.0471	4.1940	4.0886	1.196
45-49	5.0140	.0217	4.3025	4.2770	1.172

[a] Reproduced as given in India, Registrar General (1980b:14); no information is available on the weighting procedure used in combining rural and urban values.

[b] Rural and urban values were combined using the 1971 census rural-urban distribution by age.

[c] Conversion from Q(i) to F(i) was accomplished by using equations presented in United Nations (1983:Ch. 3).

TABLE 28 Testing the Consistency of Changes in Mean Parities Between the 1972 and 1979 Surveys with the Mean of Age-Specific Fertility Rates Recorded in the Two Surveys: All-India

Age Interval	Mean Parity 1972 Fertility Survey	Predicted Mean Parity 1979 Survey, Based on Column 1 and Mean Inter-survey Rates of Childbearing	Actual Mean Parity, 1979 Survey	Ratio, Actual to Predicted	Predicted Mean Parity if Fertility in 1979 Survey Raised by 5%	Ratio, Actual to Predicted Under Assumed Fertility Inflation
	(1)	(2)	(3)	(4)=(3)÷(2)	(5)	(6)=(3)÷(5)
15-19	.165	--	--	--	--	--
20-24	1.206	1.103	1.002	.908	1.130	.887
25-29	2.648	2.373	2.427	1.022	2.413	1.006
30-34	3.786	3.605	3.628	1.006	3.642	.996
35-39	4.600	4.463	4.482	1.004	4.489	.999
40-44	5.061	4.972	4.890	.984	4.987	.980
45-49	5.074	5.227	5.014	.959	5.234	.958

Below age 25, results are unstable because of rapid changes in fertility with age and because fertility experience is skewed toward the latter part of the intersurvey period. If only 1979 fertility rates are used, for example, the P/F of 1.02 from Table 27 at ages 20-24 would replace the .908 value of Table 28.

So there is a high degree of agreement between the changes in parity from the 1972 survey to the 1979 survey and the mean level of current fertility recorded in the two. The quality of the 1979 survey data on fertility thus passes an important check: consistency with reported parity. However, it should be noted that the test is not a particularly stringent one because only a minority of actual parity in 1979 is determined, through our procedure, by the 1979 survey fertility rates. The 1972 rates, and more important, 1972 parity, also affect predicted 1979 parity. To illustrate, we have arbitrarily inflated the reported 1979 age-specific fertility by 5 percent and repeated the procedure. Column 6 of Table 28 shows that the ratio of actual to predicted 1979 parity is even closer to unity at ages 25-40 than it is with uninflated fertility. Thus, Table 28 is not particularly helpful in deciding whether the 1979 fertility reports are complete or 5-percent incomplete relative to reports in the 1972 survey, although it can effectively rule out a level of 20-percent relative incompleteness if we are prepared to accept the parity values in 1979 (which are very consistent with those of the 1981 census, not analyzed here).

It could be argued that the decline in reported total fertility rates from 5.45 in 1971-72 to 4.30 in 1979 is out of line with trends in the SRS crude birth rates (Table 24). The total fertility rate declined by 21 percent, whereas the reported crude birth rate (all-India except Bihar and West Bengal) declined by only 10 percent between the 1971-72 average of 36.75 and the 1978 figure of 33.3, to which the 1979 survey pertains. Some of the disparity can be accounted for by the fact that fertility declines were largest at the older ages, which receive much heavier weighting in the total fertility rate than in the crude birth rate. At ages 20-34, which are responsible for most of the births in India, the mean decline in age-specific fertility rates between 1972 and 1979 was 18 percent, not 21 percent. Some of the remaining difference may be accounted for by age structural changes. According to the Registrar General (India, Registrar General, 1980a:49), the percentage of India's population aged 15-59 grew by 7 percent between the 1971 census and the 1979 Fertility Survey, from 52.0 to 55.9 percent. If this figure obtained within the main childbearing years, then it would account for 7 percent of the remaining 8-percent disparity between the crude birth rate trend and the trend in age-specific fertility. This comparison may overstate the age distributional change, however, since the SRS in 1971 already had a somewhat different age distribution than the census wherein 53.4 percent were between exact ages 15 and 60 (unpublished data supplied by the Registrar General). Within the SRS, then, the reported proportion 15-59 grew by 5 percent. But simulations that we have done of India's population, described in more detail in Chapter 4, suggest that even with a fairly rapid fertility decline the percentage of the population who were women of childbearing ages (15-44) probably grew by no more than 3 percent between the 1972 and the 1979 surveys. There appear to be some anomalies in the reported SRS age distributional changes, perhaps resulting from improved age reporting as units have remained in the system.

If we accept the crude birth rate trends in the SRS--which implies that we believe birth registration completeness to be about the same in 1978 as in 1971-72--then the decline in total fertility rates between these dates in the surveys is implausible. Of the 11-percent disparity in trends, 3-5 percent could be attributable to age distributional changes or to the age pattern of fertility declines, but the remaining 6-8 percent would reflect greater incompleteness of fertility reports in 1978 relative to 1972. This would be consistent with the failure of the 1979 survey to include births that were found by the enumerator but not by the supervisor. The lower end of the range is also reasonable with regard to the exercise above that compared Ps and Fs from the two surveys. The next section takes up some additional considerations of fertility levels for all-India.

2.3.2 Fertility Estimates by States

Sources for estimating fertility rates by state are the same as those available at the all-India level, except that the 1979 survey results are not available by state. Intercensal estimates are reported in Chapter 3; in this section we focus on results from the 1972 Fertility Survey. It should be noted that, despite the large size of this survey, problems of a relatively small sample size for births last year may be encountered at the state level for women at particular ages.

Table 29 presents the results of applying the P/F procedure to state data from the 1972 Fertility Survey. We have used the age-specific fertility rates and implied marital distribution from the SRS, as in case A of Table 26. Obvious typographical errors were corrected.[17]

Whereas the mean P/F for all-India at ages 20-34 was 1.01, there is clearly variation about this value at the state level. Values range from .91 in Madhya Pradesh, implying about a 9-percent overreporting of current fertility, to 1.27 in Karnataka. P/F values at different ages in the same state are reassuringly stable, varying by more than 10 percentage points only in Kerala and Punjab. Both of these states show rising P/F values with age, consistent with a fertility decline. The likelihood of a decline is confirmed by changes in the child-woman ratio between the 1961 and 1971 censuses, also shown in Table 29. Kerala has a decline of 14 percent and Punjab of 16 percent, by far the largest changes shown in the table. Since P/F is biased upward by fertility decline, there is solid reason for rejecting the relatively high correction factor implied for these states.

A second test of the adequacy of the 1972 Fertility Survey reports on births in the previous year is to compare them with results from the SRS itself, bearing in mind that the two sources are not independent. Unfortunately for comparative purposes, the 1972 Fertility Survey and the SRS did not provide identical fertility measures for the mid-1971 to mid-1972 period. The 1972 Fertility Survey provided state-specific general fertility rates for the period, and the SRS provided crude birth rates. However, the SRS also published general fertility rates for calendar years 1971 and 1972 as well as crude birth rates for those years. For comparative purposes, we have converted the SRS crude birth rates for mid-1971 to mid-1972 into general fertility rates for that period by using the mean ratio of these indices, by state, for calendar years 1971 and 1972. The ratio of crude birth rates is taken from SRS publications, as is the general fertility rate for 1971-72. Urban and rural rates are weighted by their respective state-specific proportions in the 1971 census. The results are shown in Table 30.

In most states, the two sets of rates are very close to one another; in only three states are the differences larger than 3 percent. This consistency may not reflect the accuracy of the two sources, since as noted they are not operationally independent. It is at least useful to know that tests applied to the 1972 Fertility Survey data can be assumed to pertain closely for most states to the SRS figures for the same dates; however, for three states serious inconsistency emerges. In Karnataka and Uttar Pradesh, the 1972 Fertility Survey gives general fertility rates that are 9 to 10 percent lower than the SRS rates for comparable dates; in Madhya Pradesh the 1972 Fertility Survey rate is 13 percent higher. Also shown in Table 30 is the percentage difference between general fertility rates from the 1972 Fertility Survey and the SRS general fertility rate for 1970-73. The differences are in general much larger. This disparity may reflect unusually high fertility from mid-1971 to mid-1972 or more complete recording of events in the 1972 Fertility Survey than was typical for the 1970-73 period of the SRS.

In Karnataka, the shortfall in 1972 Fertility Survey births relative to SRS births agrees with the high value of P/F from Table 29. Likewise in Madhya Pradesh, the excess of 1972 Fertility Survey births relative to those of the SRS agrees with the unusually low value of .905 for P/F, suggesting overreporting of births in the 1972 Fertility Survey, presumably from reference period bias. There is no such agreement between the sources for Uttar Pradesh, but, as Table 30 shows, SRS results for the state from mid-1971 to mid-1972 are anomalous relative to the whole 1970-73 period, and P/F is not out of line with these latter results. Table 30 for the 1970-73 period also tends to weakly confirm the possibility indicated by P/F of overreporting of births for Gujarat and Haryana and of underreporting of births for Orissa. The only state for which there is substantial disagreement between Table 30 and P/F results is Maharashtra, inasmuch as P/F there shows a 5-percent deficiency of births in the 1972 Fertility Survey, but 1972 Fertility Survey births exceed those for the SRS in the 1970-73 period by 9 percent. It may be, of course, that both indications are correct and that 1972 Fertility Survey births are 5 percent too low and that the SRS births are even lower.

It appears that, except for Kerala and Punjab, in which declining fertility has biased the P/F upward, the P/F procedure provides a reasonable basis for adjusting 1972 Fertility Survey births. Note that the adjustment is less than 5 percent in 7 of the 12 other states. The total fertility rates and the crude birth rates that

TABLE 29 Cumulative Fertility Compared with Current Fertility via the P/F Method, 1972 Fertility Survey, by State: Selected States and All-India

State	Total Fertility Rate, 1972 Fertility Survey[a]	P/F 20-24	P/F 25-29	P/F 30-34	P/F Mean	Percentage Change in Ratio, Children Aged 0-4 to Women Aged 15-44 Between Census of 1961 and 1971[b]	Corrected Total Fertility Rate, 1971-72 Column 1 x Column 5	Corrected Crude Birth Rate 1971-72[c]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	4.656	1.022	1.038	1.029	1.030	+2	4.80	36.7
Assam	5.529	1.105	1.187	1.155	1.149	+3	6.35	43.4
Bihar	4.931	0.904	1.009	.978	.964	-3	4.75	33.2
Gujarat	6.131	.950	.976	.997	.974	-7	5.97	42.0
Haryana	6.894	.979	.952	.958	.963	-7	6.64	43.3
Karnataka	4.327	1.232	1.247	1.330	1.270	-1	5.50	35.9
Kerala	4.492	1.056	1.166	1.146	1.123	-14	4.49[d]	32.6[d]
Madhya Pradesh	6.808	.902	.923	.889	.905	-2	6.16	40.8
Maharashtra	4.697	1.045	1.059	1.041	1.048	-1	4.92	35.2
Orissa	4.819	1.200	1.160	1.086	1.149	+8	5.54	39.6
Punjab	5.574	1.020	1.132	1.115	1.089	-16	5.57[d]	35.9[d]
Rajasthan	6.629	1.015	.919	.957	.963	+1	6.38	42.3
Tamil Nadu	4.178	1.101	1.106	1.084	1.097	-2	4.58	35.4
Uttar Pradesh	7.086	1.026	.948	.942	.972	+4	6.89	44.5

State-weighted estimate, All-India (except Bihar and West Bengal)	5.68[e]	39.3
All-India (except West Bengal)	5.57[e]	38.7

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[a] Source: India, Registrar General (1976b). Urban and rural age-specific fertility rates are applied for women at each age to the urban-rural distribution from the 1971 census. Marital distributions are those of the 1972 survey, derived as in Notes 14 and 17 of Chapter 2.

[b] Dyson (1979b).

[c] The general fertility rate of the 1972 Fertility Survey is multiplied by the ratio of crude birth rates 1971-72 to the general fertility rate, 1971-72, from the SRS, by state. The resulting estimated 1972 Fertility Survey crude birth rate is multiplied by the P/F from column 6. No general fertility rate estimate is available for Bihar from the SRS; the proportion of the Bihar population who are women aged 15-49 in the 1971 census (.2268) is used to convert the 1972 Fertility Survey general fertility rate into the crude birth rate. In Uttar Pradesh, the proportion of population who were women aged 15-49 in the 1971 census was used for the conversion because the implied SRS value was implausibly lower than in any other state and showing the largest discrepancy from census values.

[d] Uncorrected.

[e] Weighted by number of women aged 15-49 in 1971 census.

TABLE 30 Comparison of General Fertility Rates from the 1972 Fertility Survey to Those in the SRS: Selected States of India

State	General Fertility Rate, Mid-1971 to to Mid-1972, from the 1972 Fertility Survey	Percentage Excess (+) or Deficit (-) of the General Fertility Rate from the 1972 Fertility Survey Compared with the SRS Rate	
		Mid-71 to Mid-72	1970-73
Andhra Pradesh	149.9	-0.6	2.8
Assam	177.2	-2.9	2.2
Bihar	152.9	--	--
Gujarat	187.2	2.7	10.5
Haryana	208.5	0.0	9.9
Karnataka	131.6	-9.2	-7.8[a]
Kerala	131.6	-2.3	7.3[a]
Madhya Pradesh	211.8	12.7	18.0
Maharashtra	147.4	0.0	8.7
Orissa	149.9	-2.7	-2.7
Punjab	159.8	-0.7	4.4
Rajasthan	201.1	-0.3	--
Tamil Nadu	129.3	-1.3	4.2
Uttar Pradesh	213.6	-9.7	-1.6

[a] Denominator based on 1971-73 only.

Source: India, Registrar General *Sample Registration Bulletin* (various issues); and unpublished data supplied by the Registrar General.

result from multiplying the original values of these variables by P/F are shown in Table 29. Before accepting these as final estimates, of course, it is necessary to compare them to estimates derived from other sources. At this point it should be noted that Bihar's estimated crude birth rate and total fertility rate are almost surely too low in Table 29; evidently, the problems associated with SRS operations in Bihar extended to the 1972 Fertility Survey. The same seems true of West Bengal, which participated in the survey but for which no data on the volume of fertility in rural areas were published.[18]

The state-weighted total fertility rate for all-India (except West Bengal) in Table 29 is 5.57, compared with 5.51 using comparable procedures in Table 26. This difference is surely tolerable; however, when Bihar is excluded from the calculations in Table 29 the state-weighted estimates rise to 5.68. The below-average fertility of Bihar in the 1972 Fertility Survey is simply not credible: Table 24 shows that Bihar had much higher fertility than all-India in 1979, when SRS results from the new sample area in Bihar were reported for the first time; likewise, intercensal analysis reported in Chapter 3 shows Bihar to be a moderate to high-fertility state.

On the other hand, there is reason to believe that the P/F procedure results in too high a TFR in Uttar Pradesh. As we show in the next chapter, the TFR for the state based on 1961-71 population change is only 6.45 (mean, forward, and reverse survival). It seems unlikely that fertility could have risen to 6.89 by 1971-72, and other evidence in Chapter 4 shows that an Uttar Pradesh level of 6.89 in 1971-72 produces too high a TFR for all-India as well. One source of the problem may be that age-specific (but not overall) fertility and parity could be too high at young ages in Uttar Pradesh because of an unusually strong tendency (suggested by the age distribution) for unmarried or nulliparous women to be reported below age 15 or 20. So in deriving TFR as a state-weighted average for all-India, we have used a TFR value of 6.45 in Uttar Pradesh. This reduces the value of the all-India (except Bihar and West Bengal) TFR to 5.59; including an adjustment so that Bihar and West Bengal are represented raises the all-India TFR to 5.60. This figure of 5.60 for India's TFR in 1971-72 is tentatively adopted. The all-India CBR (without Bihar and West Bengal) of 39.3 is adopted for all-India including these states, since Chapter 3 results imply that the inclusion of these two states has a small and unsystematic effect on the aggregate crude birth rate.

If the crude birth rate estimate of 39.3 in 1971-72 is correct, it implies that the SRS results are deficient for that period. From Table 24, the mean SRS crude birth rate for all-India (except Bihar and West Bengal) in 1971 and 1972 was 36.75. This figure implies a deficiency of 6.4 percent in SRS birth rates and a somewhat larger deficiency if Bihar and West Bengal are included. It should be remembered, however, that births in the SRS from mid-1971 to mid-1972 were probably atypically complete because of the operation of the 1972 Fertility Survey itself. The mean of the SRS 1970-73 birth rates (a period that includes one unusually good year and one unusually bad one, 1973) is 36.22, which is deficient by 7.8 percent without Bihar and West Bengal.

We have suggested that the reported total fertility rate of 5.45 births per woman in the 1972 Fertility Survey should be adjusted upward by 2.8 percent to 5.60.

Earlier we argued that births in the 1979 survey are perhaps 6-percent deficient relative to those in the 1972 survey. Together, these pieces of information suggest that the 1979 survey's total fertility rate of 4.3025 for 1978 should be adjusted upward to 4.3025 (1.028) (1.06) = 4.69. The plausibility of this figure is tested in Chapter 4. It is very close to the value (4.72) provided by the simple P/F method.

We can investigate the implied completeness of SRS birth registration by state by comparing SRS birth rates for 1970-73 with those derived on the basis of the 1972 Fertility Survey. Results are shown in Table 31. Incompleteness ranges from 15.3 percent in Assam to 1.6 percent

TABLE 31 Estimated Completeness of SRS Birth Rates by State, 1970-73, and Implied Crude Birth Rate Estimates, 1979: Selected States and All-India

State	Ratio, Mean SRS Crude Birth Rate, 1970-73 to Estimated Fertility Survey Birth Rate, 1971-72	1979 SRS Crude Birth Rate (old sample areas) if Completeness Same as Estimated for 1970-73 (column 1)
	(1)	(2)
Andhra Pradesh	.937	34.0
Assam	.847	38.3
Bihar	--	--
Gujarat	.932	38.3
Haryana	.913	39.9
Karnataka	.871	33.2
Kerala	.944	27.6
Madhya Pradesh	.950	39.8
Maharashtra	.886	30.6
Orissa	.896	36.2
Punjab	.947	30.9
Rajasthan	.954	36.9
Tamil Nadu	.874	32.2
Uttar Pradesh	.984	40.2
West Bengal	--	--
All-India	.922[a]	36.0[b]

[a] Ratio, SRS all-India birth rates 1970-73 without Bihar and West Bengal to estimated all-India rate for 1971-72.

[b] Ratio, SRS birth rates, all-India except Bihar and West Bengal, to column 1.

in Uttar Pradesh. There seems to be no correlation between state-specific incompleteness estimates for birth rates and those for death rates previously shown; however, we have already concluded that there is no firm basis for inferring interstate differences in death registration completeness.

Unfortunately, we have no independent source with which to evaluate the completeness of SRS birth rates later in the decade. Let us assume constancy of underregistration and suppose that the state-specific completeness estimates of Table 31 were applied to SRS crude birth rates in 1979. The old sample areas should be used since they are the ones for which completeness was estimated. Results in Table 31 represent the latest period for which birth rates can be estimated in this report. The ultimate check on the assumption of constant underregistration is the intercensal growth rate, which is incorporated in Chapter 4.

NOTES

1. Effective duration of marriage was determined by relating reported age at first cohabitation to reported current age in the case of married women, regardless of how many times married, and to reported age at termination of marriage in the case of widowed, divorced, or separated women.
2. In particular, the state values of children ever born and children surviving per mother by age as given in India, Registrar General (1976b) for rural and urban areas were weighted by the number of ever-married women by age in urban and rural areas (India, Registrar General, 1977a). The only areas that could not be included in this calculation because of the absence of fertility/mortality data were Sikkim and Nagaland, which constitute about .001 of the total population.
3. In particular, the logit of p(x) is subtracted from the logit of p(x) in the South model life table of level 11; the average logit difference from the standard is then used to derive the graduate q(2) values. In doing this we have ignored the estimates of q(1), as it is typically biased upward due to age of mother and birth-order differences in child mortality. The estimate of q(10) was also ignored

in order to keep the effect of recall lapse to a minimum.

4. In the investigations of couple fertility of the NSS, stillborn babies were included in the calculation of children ever born to a woman. The analysis presented here, however, is based on the information collected in the 12th schedule of the NSS, which does not include stillborn babies.
5. During the period 1961-70, net national product at constant prices increased at an annual rate of 3.3 percent and gross value of output from agriculture at 2.5 percent (India, Central Statistical Organisation, 1975a, 1975b), while the population increased at a rate of 2.2 percent.
6. In the 16th round of the NSS, CEB/CS data were tabulated by age categories of 17-21, 22-26, etc. Regression coefficients used in converting this information into q(x) values, developed by P. N. Mari Bhat, appear in Appendix B.
7. The all-India data of the 1965-66 NSS indicate that child mortality among Hindus is slightly higher than that of the total population--the graduated value of q(2) for Hindus is 0.231, and for the total population it is 0.225. The corresponding values for Muslims and Christians are 0.206 and 0.156, respectively. Relatively low child mortality among Christians may be at least partly due to the fact that they reside in relatively low mortality areas, such as Kerala and Assam.
8. To some extent the implied increase in child mortality is also the result of graduation. An example may help in clarifying this: for q(10) value of 0.197, q(2) value in the South model life tables (both sexes) is 0.154; but the logit transformation using South model level 11 (both sexes) as the standard yields an estimate of q(2) of 0.143.
9. The "level" of mortality implied by the $_5M_0$ values of the SRS is identified by comparing it with the $_5M_0$ values in South model stable populations (both sexes) with a growth rate of 0.020 and varying "levels" of mortality. The q(2) value in the South model life table (both sexes) corresponding to the identified "level" is taken as the requisite estimate.
10. The estimated reference dates of the graduated q(2) values of all-India are also roughly applicable to the state-specific estimates. The differences among

states in age-specific parity distributions are too small to have a significant impact on the estimates of the time references of the q(x) values.

11. Life expectancy at age 70 was computed on the basis of age-specific growth rates and death rates, in the age interval 70+ by the procedure recommended by Horiuchi and Coale (1982). The mean age at death for persons dying below age 1 was taken to be .25 years and for persons dying between 1 and 5, 2.25 years.
12. The Brass and Preston-Coale procedures were applied to state-specific SRS data for 1970-71, 1972-74, and 1975-76, supplied to the panel for this purpose by the Registrar General. The Brass procedure was tried for the age ranges 5-50 and 20-60; results from the two ranges for females were similar in level and regional pattern, but for males the 5-50 range seemed to give quite erratic results, perhaps because of net interstate migration. The Preston-Coale results were computed based on three different assumed growth rates, each of which was an output of the Brass procedure applied to ages 5-50 but with 0, 1, and 2 ages trimmed. Preston-Coale completeness was estimated for each growth rate and for each starting age ranging from 0-65. The growth rate producing the smallest mean absolute deviation from age to age was adopted, together with its associated mean completeness estimate.
13. For birth rate estimates, it is clearly necessary to use the death rate at all ages combined. For this reason, growth rate and completeness estimates should refer to ages 0+. The growth rate used for each state was that derived from the Brass procedure fit to ages 5-50, without trimming. Using this age span employs the maximum amount of information on the population aged 0-4. The implied value of r was then substituted into the Preston-Coale procedure, and the completeness estimate for age 0+ was adopted. It should be noted that there was relatively little variation in completeness estimated by Preston-Coale according to the initital age chosen.
14. The ever-married distribution from the 1972 Fertility Survey was not directly available. The currently married distribution from the survey was derived by dividing age-specific fertility rates by age-specific marital fertility rates, except at ages 45-49, for which the process yielded a proportion married

greater than unity. A value of unity was thus substituted. To the proportion currently married was added the census proportion widowed and divorced by age. Although this age schedule was not directly available from the survey, the total proportion widowed/divorced/separated above age 10 was available and it corresponded very closely to the 1971 census proportion widowed/divorced/separated (see note 15).

15. For population over age 10, the following marital status distributions were recorded in census and survey:

	1971 Census		1972 Fertility Survey	
	Rural	Urban	Rural	Urban
Single	.207	.292	.249	.330
Married	.657	.590	.619	.556
Others	.136	.118	.133	.114

16. The procedure is the following. Mean parity in 1972 by cohort was increased by the rate in the three age intervals at which the cohort bore children during the 6.5 years between 1972 (July 1) and 1979 (January 1). Using lexis diagram reasoning and recognizing that the age-specific fertility rates reported for ages x to x + 5 in fact refer to ages x - 0.5 to x + 4.5, a cohort will spend 2.025 years between the surveys bearing children at the rate for the interval in which it started, 4.075 years at the rate of the next interval (x + 5 to x + 10), and 0.4 years at the rate of the interval x + 10 to x + 15. Age-specific fertility rates are assumed to be constant within five-year intervals. By 1979, the cohort aged x to x + 5 in 1972 was aged x + 6.5 to x + 11.5. The cumulative parity in 1979 for age x to x + 5 was derived as

$$\frac{3.5}{5}\,{}_5P_x + 1.5 + \frac{1.5}{5}\,{}_5P_x - 3.5.$$

17. For some cases, the proportion currently married from the survey, together with the proportion widowed, divorced, or separated from the census, implied an ever-married proportion of greater than unity. In such instances we have accepted the census ever-married proportion; the fertility rate of the age interval was adjusted such that the sum of fertility and marital fertility rates of the interval produced the recorded sum. The rural parity value for Rajasthan of 5.46 at ages 30-34 was changed to 4.46, giving among other things a reasonable proportion dead and age progression of parity; at ages 20-24 in Gujarat the values for children ever born and children surviving of 1.53 and 1.81 were assumed to have been transposed.
18. It is not clear whether results for West Bengal are included in all-India values in the published report of the survey. Parity values for West Bengal are presented, but current fertility values are not, although the information was gathered (India, Registrar General, 1976b:70-73).

3 CENSUS-BASED ESTIMATES

3.1 DECADE OF 1961-71

Intercensal analysis is a venerable and still very useful means of obtaining demographic estimates for India and its states. In this chapter we concentrate on the intercensal period from 1961 to 1971. The method we employ to make intercensal estimates for the 1961-71 decade is essentially a modification of the intercensal survival technique originally suggested by Coale and Demeny (1967). The first step is the production of intercensal life tables from the indications of survivorship between two censuses. This aspect requires projecting the age distribution from the first census forward by 10 years using survival rates implied by model life tables covering a wide range of mortality levels. Comparison of the cumulated projected populations above given ages at the second census (e.g., 10+, 15+, etc.) with the cumulated populations actually enumerated above those ages gives a series of estimates of the level of mortality of the nonchild (mainly adult) population corresponding to a series of open-ended survivorship ratios. Cumulated populations are compared because of the dampening effect that cumulation has on age-misreporting. Therefore, unlike the method employed by the Registrar General to compute the official life tables, this technique does not involve prior smoothing of census age distributions. The resulting mortality estimates are often expressed in terms of a series of values of life expectancy from age 5 (e_5), and a composite estimate of nonchild mortality is usually selected with reference to the first nine age-specific values of implied e_5.

It has been shown that, ceteris paribus, estimates of e_5 derived by this procedure vary little, regardless of the model life table pattern employed (Coale and Demeny, 1967:12). However, the relationship between child mortality and mortality above age five varies considerably between model life tables. Therefore, without additional information on the nature of this relationship, one cannot confidently extrapolate from the e_5 estimate to obtain an estimate of child mortality (and thus an estimate of life expectancy from birth). But in the case of India we do have independent estimates of the level of child mortality, presented in Chapter 2. In order for the life tables derived from censal survival analysis to incorporate these child mortality estimates, we took advantage of the two-parameter logit life table system developed by Brass (1975). This system was used to combine estimates of child mortality with estimates of nonchild mortality derived from the census survival analysis. Specifically, the value of child mortality as gauged by survivorship to age two (l_2) was fixed at levels shown in Table 17. Then, using a South model life table (level 11) as standard, β--the slope parameter in the logit life table system--was systematically varied to generate a set of life tables embodying a wide range of relationships between adult mortality and the stipulated level of child mortality as indicated by the fixed level of l_2.[1] These life tables were then used to project the age distribution of the first census. Comparison of the projected to the enumerated populations above given ages identified for each age the best-fitting value of β and the corresponding values of e_5. The South model life table system was chosen because it provided the best representation of relationships between child and adult mortality in the SRS data.

Construction of life tables by sex necessitated a state-by-state examination of sex differentials in child mortality. Table 32 presents such differentials (m-f) in mortality to age two (q_2) implied by the Sample Registration System's infant mortality rates for 1968-70 as well as those contained in the child mortality data from the 1972 Fertility Survey. Note that, for most states, both sources concur on the direction and approximate magnitude of the sex differential. Note, too, the indication that survivorship is lower among males than among females in all the southern states, while the reverse is generally true in the north. This regional clustering bolsters one's confidence in the results. To obtain sex-specific values of l_2 for the construction of life tables, the mean sex differentials in mortality (column 3) were applied to the mid-decade q(2) values from Table 17 of Chapter 2, and the complements give sex-specific

TABLE 32 The Derivation of Sex-Specific l_2 Values for the 1961-71 Intercensal Analysis: Selected States and All-India

State	S.R.S.[a] Δq_2 * 1000 m-f	Fertility Survey[b] Δq_2 * 1000 m-f	Mean Δq_2 * 1000 (1)+(2)/2.0	q_2 Both Sexes Combined[c]	Sex-Specific Values of Survivorship to Age 2 (l_2) Male	Female
	(1)	(2)	(3)	(4)	(5)	(6)
Andhra Pradesh	+22	+15	+18.5	.176	.8148	.8333
Assam	+26	+23	+24.5	.157	.8308	.8553
Bihar	-12	-11	-11.5	.190	.8158	.8043
Gujarat	-6	-4	-5.0	.166	.8365	.8315
Haryana	-12	-9	-10.5	.163	.8423	.8318
Karnataka	+12	+10	+11.0	.155	.8395	.8505
Kerala	+14	+10	+12.0	.099	.8950	.9070
Madhya Pradesh	-4	0	-2.0	.197	.8040	.8020
Maharashtra	-2	-4	-3.0	.153	.8485	.8455
Orissa	+12	+5	+8.5	.202	.7938	.8023
Punjab	-18	-20	-19.0	.138	.8715	.8525
Rajasthan	-10	-10	-10.0	.186	.8190	.8090
Tamil Nadu	+20	+24	+22.0	.180	.8090	.8310
Uttar Pradesh	-24	-5	-14.5	.262	.7453	.7308
West Bengal	+2	-3	-0.5	.141	.8593	.8588
All-India	-2	+2	0	.184	.8160	.8160

[a] Based on mean sex-specific SRS q(1) values for 1968-70, transformed to q(2) (principal source: Dyson, 1979b).

[b] Three sex differentials in graduated values of q(2) are those implied by the sex-specific q(x) values found in Natarajan (1980).

[c] Source: column 3 of Table 17.

values of l_2 (columns 5 and 6). For all-India this procedure produces identical early age survivorship among males and females.

Intercensal survival analysis requires that the age distributions for both censuses refer to the same geographical area and that adjustments are made for intercensal interstate migration. The age distributions for five states--Assam, Bihar, Uttar Pradesh, Punjab, and Haryana--needed adjusting for intercensal changes in state boundaries. These adjustments were minimal with regard to the first three states but quite substantial in the case of the last two. In particular, large parts of what was formerly the Punjab were transferred during the 1961-71 intercensal period to form the new state of Haryana and the Union Territory of Chandigarh. Additional areas of Punjab were transferred to Himachal Pradesh. It did prove possible to make satisfactory allowance for these changes in all cases.

State-specific total net intercensal migration estimates by sex derived from a census question on duration of residence are given in Table 33. Age-specific data on respondents giving their duration of residence as 0-9 years were used to make some allowance for net intercensal migration. It is worth noting that according to this data females are generally less mobile than males. The population of the country as a whole during the 1961-71 decade can effectively be considered closed.

A summary of the results of applying the intercensal survival technique to the data for all-India is presented in Table 34. Given that the values of survivorship to age two (l_2) have been fixed, variation in the estimates of implied life expectancy at birth (e_0) as the age range of estimation varies is explained almost totally by variation in implied nonchild mortality. This variation is also reflected in the progression of β. The sequence of β values is, naturally enough, consistent with the characteristics of age-misstatement in India. The e_0 figures range from 42.0 to 51.1 years for males and 41.2 to 48.8 years for females. The implied low survivorship (high β) at 15+/5+ and high survivorship (low β) at 25+/15+ are consistent with a substantial deficit of persons recorded as ages 15-19 in both censuses. When these two estimates are eliminated from the series, the range of implied e_0 is very substantially reduced. Table 34 shows that similar estimates result whether one accepts the mean or median β values, although the exact choice is inevitably arbitrary.

If we accept the parameters stemming from the mean values of β, then life expectancy at birth (e_0) is estimated at 46.8 years for males and 45.3 years for females. Since the l_2 values for the two sexes are identical (see Table 32), the difference in e_0 relates to nonchild mortality and results from the implications of differential census survivorship between the two sexes. Indeed, the estimated value of life expectancy from age five (e_5) for males is 1.7 years greater than that for females.

The estimates of life expectancy at birth presented here for all-India are not very different from those contained in the official life tables of India, 1961-71, which are also based on intercensal cohort comparisons but with graduation procedures substituting for the use of model life tables. The official tables contain a life expectancy at birth of 46.4 for males and 44.7 for females (India, Registrar General, 1977b). However, the e_0 in the official tables is obtained with a very different combination of child and adult mortality than that suggested here. In the official tables e_5 is 52.0 (males) and 50.2 (females), compared with estimates here of 55.6 and 54.0. This discrepancy seems to result mainly from a decision made in producing the official tables to reduce the enumerated population of adults in 1971 so that the total population of each sex was unchanged when the number of children in 1971 was inflated to account for results of a special postenumeration inquiry. This reduction created the appearance of fewer intercensal survivors and hence of higher adult mortality between censuses (Dyson, 1979a). It appears that e_5 in the official tables is too low. At the same time, the official tables used an estimate of intercensal mortality below 5 that was considerably lower than that recorded by SRS at the end of the decade (Dyson, 1979a). But the new information uncovered on child mortality in Chapter 2 provides strong indication that intercensal child mortality was higher even than that contained in the end-decade SRS. So the official life tables appear to contain two large differences that are offsetting in their effects on e_0. They are not offsetting, however, in their effects on mortality parameters at other ages or on fertility estimates based on intercensal experience.

The same technique was applied to data for states, using the state- and sex-specific level of q(2) in the construction of a series of β-varying South model life tables. Once again, values corresponding to the mean of the first 9 β values were adopted. The state-level estimates are summarized in Table 35. For males, the e_5 estimates fall mainly in the age range 54-58. According to these figures three states in particular--Kerala, Punjab, and Haryana--have comparatively low levels of nonchild mortality. It is interesting to recall that these states (especially the first two) also appear to have relatively low levels of infant and child mortality. The combined effect is to produce estimated intercensal values of life expectancy at birth of 57.7, 55.4, and 52.0 years, respectively. The value of e_5 for West Bengal of 51.0 years is particularly low, and the β value for this state, 1.40, is implausibly high.

Table 35 also presents the estimated life table parameters for females. The estimated values of e_5 for females are more variable than those for males. Again, Kerala and Punjab appear to have comparatively favorable levels of female nonchild mortality. The lowest e_5 value is for Uttar Pradesh, and, combined with the assumed levels of child mortality, it results in an estimate of life expectancy at birth of only 37.3 years.

The analysis was also conducted with age distributions that were not adjusted for migration in order to assess the impact that such adjustment has on the estimated values of nonchild mortality. The mean absolute difference in e_5 estimates between the two series, adjusted and unadjusted for migration, was 0.7 years for females and 1.1 years for males, the more migratory sex. It is quite possible, however, that some of the estimates in Table 33 as to both the magnitude and the direction of intercensal migration are misleading. The β values for West Bengal and Karnataka are particularly high. Assuming that the levels of child mortality estimated for these states are of the right order of magnitude, they are indicated to have unusually heavy adult mortality, which may result from an overestimate of net in-migration.

The production of intercensal life tables allows the estimation of crude birth and death rates by the procedures of reverse and forward survival. The estimated state-level life tables were used to back-project the unadusted age group 0-9 enumerated in 1971 to give an estimate of the intercensal crude birth rate (reverse survival). The 0-9 age group was employed to help minimize errors due to omissions and age-misreporting among young children. Subtraction of the average annual intercensal rate of growth from this birth rate gives an estimate of the death rate for the decade. Forward

TABLE 33 Estimates of Net Intercensal Migration, by Sex and for the 1951-61 and 1961-71 Intercensal Decades; Total Numbers and Rates: Selected States and All-India

State	1951-61[a]				1961-71[b]			
	Total (1,000s)		Average Annual Rate (per 1,000)		Total (1,000s)		Average Annual Rate (per 1,000)	
	Male	Female	Male	Female	Male	Female	Male	Female
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	-121	-73	-9.72	-0.44	-50	-32	-0.25	-0.16
Assam	+545	+312	+10.54	+6.91	+79	+22	+1.14	+0.36
Bihar	-443	-71	-2.08	-0.33	-322	-116	-1.23	-0.46
Gujarat	+77	-6	+0.81	-0.07	+54	+14	+0.44	+0.12
Haryana	--	--	--	--	+27	+31	+0.57	+0.76
Karnataka[c]	+153	+100	+1.40	+0.95	+36	+10	+0.27	+0.08
Kerala	-218	-82	-2.90	-1.06	-152	-85	-1.60	-0.88
Madhya Pradesh	+311	+207	+2.08	+1.45	+158	+129	+0.83	+0.72
Maharashtra	+583	+260	+3.16	+1.50	+461	+220	+1.98	+1.01
Orissa	-74	-76	-0.92	-0.94	+57	+72	+0.58	+0.73
Punjab	--	--	--	--	-79	-78	-1.19	-1.37
Rajasthan	-211	-85	-1.28	-0.99	-159	-111	-1.32	-0.92
Tamil Nadu[d]	-213	-154	-1.33	-0.97	-69	-58	-0.37	-0.31

Uttar Pradesh	-829	-187	-2.31	-0.57	-715	-327	-1.67	-0.86
West Bengal	+1,637	+962	+10.01	+6.75	+220	+15	+1.05	+0.08
Composite Punjab[e]	-144	-84	-1.60	-1.08	--	--	--	--
All-India	+1,756	1,340	-0.86	-0.69	--	--	--	--

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[a] Computed from 1961 census data on duration of residence 0.9 years plus the estimates of net international migration contained in Zachariah and Seetharem (1968:47-63). The estimates of international migration are very rough, yet they form a very substantial component of the net (1951-61) interstate migration estimates for adjoining eastern states of Assam, Bihar, and West Bengal.

[b] Computed from 1971 census data on duration of resident 0-9 years kindly supplied by the Registrar General of India.

[c] Known during the 1951-61 decade as Mysore.

[d] Known during the 1951-61 decade as Madras.

[e] The erstwhile Punjab of 1961, consisting essentially of what are now Punjab and Haryana.

TABLE 34 Estimates of α, β, e_0, and e_5, Corresponding to Proportions Surviving to Age x and Over in 1971, from Age x-10 and Over in 1961, Males and Females: All-India

Age at Second Census (x)	Male				Female			
	α	β	e_0	e_5	α	β	e_0	e_5
	(1)	(2)	(3)		(4)	(5)	(6)	(7)
10	-.0920	1.0230	47.24	55.95	+.0232	1.2035	43.72	51.98
15	+.0828	1.2969	42.04	50.09	+.1129	1.3440	41.24	49.18
20	-.0898	1.0264	47.17	55.87	-.1203	.9786	48.17	56.99
25	-.2054	.8452	51.14	60.35	-.1403	.9472	48.84	57.76
30	-.1174	.9831	48.08	56.89	+.0046	1.1743	44.26	52.59
35	-.0747	1.0501	46.68	55.32	+.0107	1.1838	44.08	52.39
40	-.0764	1.0475	46.74	55.38	-.0297	1.1207	45.28	53.75
45	-.0642	1.0664	46.35	54.95	-.0490	1.0903	45.88	54.42
50	-.0604	1.0725	46.23	54.82	-.0688	1.0593	46.49	55.11
Based on Mean of β	-.0775	1.0457	46.77	55.42	-.0285	1.1224	45.25	53.71
Based on Median of β	-.0764	1.0475	46.74	55.39	-.0297	1.1207	45.28	53.75

Note: For the standard life table South level 11 see Note 4 to the text. Alpha (α) is the level parameter in the two-parameter life table system (see Note 4).

TABLE 35 Estimated Life Table Parameters (α, β, e_0, and e_5), by Sex and State: Selected States and All-India

State	Male				Female			
	α	β	e_5	e_0	α	β	e_5	e_0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	-.0224	1.1257	53.56	45.05	-.0345	1.2069	52.96	45.65
Assam	-.0908	1.1046	54.99	47.32	-.1355	1.1799	55.00	48.91
Bihar	-.0980	1.0125	56.18	47.43	+.0824	1.2367	50.64	41.84
Gujarat	-.1107	1.1057	55.32	47.99	-.1622	.9966	57.49	49.62
Haryana	-.2318	.9496	59.30	51.98	-.1061	1.0862	55.46	47.81
Karnataka	-.0805	1.1703	54.13	47.09	-.0757	1.2436	53.36	47.08
Kerala	-.4157	1.0276	61.50	57.73	-.4188	1.1283	60.46	57.61
Madhya Pradesh	-.0338	1.0531	54.58	45.27	-.0308	1.0479	54.59	45.12
Maharashtra	-.1425	1.1266	55.66	49.07	-.1633	1.0760	56.57	49.71
Orissa	+.0258	1.0966	53.05	43.32	.0491	1.1745	51.81	42.75
Punjab	-.3370	.9718	60.83	55.42	-.2532	.9779	59.31	52.68
Rajasthan	-.0794	1.0584	55.31	46.86	-.0944	.9831	56.49	47.27
Tamil Nadu	-.1059	.9652	56.92	47.65	-.0639	1.1479	54.06	46.50
Uttar Pradesh	+.0302	.8886	55.72	42.63	+.1991	1.0945	50.16	37.26
West Bengal	-.0134	1.3969	51.02	45.48	-.0863	1.2794	53.24	47.50
All-India	-.0775	1.0457	55.42	46.77	-.0285	1.1224	53.71	45.25

survival consists of applying the state-level life tables to the estimated mid-decade state populations to obtain an estimate of the average decadal crude death rate; summing this death rate and the average annual intercensal rate of growth gives an estimate of the birth rate for the period.

Table 36 presents the resulting estimates of birth rates. Columns 2 and 3 contain the estimates obtained by using the unadjusted state age distributions. Column 4 contains crude birth rates calculated using the state-level life tables and the Registrar General's adjusted 0-4 age groups (India, Registrar General, 1977c). Columns 5 and 6 present total fertility rates calculated by indirect standardization corresponding to the crude birth rates in columns 1 and 2.[3]

It should be stressed that the two sets of estimates in columns 2 and 3 are not completely independent. For example, if the levels of child mortality incorporated in the life tables are indeed too low, then the resulting estimated crude birth rates by both reverse and forward survival will also be too low. Omitting the 0-9 age group differentially from the census could have a similar effect. Nevertheless, the degree of correspondence between the estimates of the crude birth rates is encouraging; the correlation coefficient of the figures in columns 1 and 2 is quite high (r = 0.96). It is also of interest to note that the reverse survival birth rates based on the unadjusted 0-9 age group are not systematically lower than those derived using the Registrar General's adjusted age distribution at ages 0-4.

Table 37 presents the corresponding estimates of the crude death rate. Again, agreement between the two sets of figures is close.

A related procedure to that described above adopts the life table produced by the SRS as the "model" for intercensal analysis. Comparison of the 1971 population to that projected for 1971 by applying the SRS life table to the 1961 age distribution provides a test of consistency of the SRS data with intercensal survival experience. Results of this procedure, using an SRS-based life table for 1969-71, are shown in Table 38.[4]

For males there appears to be a high degree of consistency between intercensal survival experience and adult mortality experience recorded in the SRS at the end of the decade. The ratio of actual to projected population begins to rise after ages 40-44 at the second census, slowly at first and then quite rapidly. Presumably this

TABLE 36 Intercensal Crude Birth Rates and Total Fertility Rates, 1961-71, Estimated Using the State-Level Life Tables and Procedures of Reverse and Forward Survival: Selected States and All-India

State	Reverse Survival Based on Unadjusted Number of Children 0-9	Forward Survival	CBR, 1966-71 Reverse Survival Based on Adjusted Children 0-4	Total Fertility Rates by Indirect Standardization	
				Reverse	Forward
(1)	(2)	(3)	(4)	(5)	(6)
Andhra Pradesh	39.0	37.9	40.1	5.08	4.94
Assam	47.3	46.0	44.0	6.94	6.76
Bihar	42.4	39.6	42.0	5.81	5.42
Gujarat	41.3	41.6	39.2	5.81	5.85
Haryana	44.3	43.7	44.4	6.95	6.87
Karnataka	39.7	39.0	36.4	5.55	5.46
Kerala	33.8	35.8	34.5	4.57	4.83
Madhya Pradesh	46.0	44.1	46.7	6.53	6.26
Maharashtra	39.6	38.8	39.8	5.34	5.24
Orissa	42.5	42.1	39.8	5.74	5.70
Punjab	35.4	34.8	35.5	5.56	5.47
Rajasthan	44.3	43.4	43.8	6.39	6.28
Tamil Nadu	36.2	37.4	37.5	4.58	4.74
Uttar Pradesh	45.1	43.0	44.7	6.60	6.29
West Bengal	40.4	40.7	40.7	5.90	5.96
All-India	41.3	40.6	41.2	5.77	5.67

TABLE 37 Crude Death Rates, 1961-71, Estimated Using the State-Level Life Tables and the Procedures of Reverse and Forward Survival: Selected States and All-India

State	Crude Death Rates	
	Reverse[a]	Forward[b]
(1)	(2)	(3)
Andhra Pradesh	19.9	18.7
Assam	18.0	16.7
Bihar	22.3	19.5
Gujarat	15.8	16.1
Haryana	16.9	16.3
Karnataka	18.1	17.4
Kerala	9.4	11.3
Madhya Pradesh	21.5	19.6
Maharashtra	16.6	15.9
Orissa	20.6	20.3
Punjab	14.5	13.9
Rajasthan	18.6	17.8
Tamil Nadu	15.8	17.0
Uttar Pradesh	26.0	23.8
West Bengal	17.1	17.4
All-India	19.1	18.4

[a] Corresponds to column 2 of Table 36.
[b] Corresponds to column 3 of Table 36.

pattern reflects persistent age overstatement at the higher ages. The mean ratio for the first eight ages (i.e., for all those below 50 at the second census) for males is 1.005. For the first six ages, the mean ratio is 1.000. Thus, there is little reason for concern about inconsistencies between intercensal survival experience for males and mortality levels recorded in the SRS.

For females, however, the comparison is less satisfactory, as shown in Table 38. The mean of the first eight ratios of actual to expected population for females is .976 and of the first six it is also .976. The two most likely explanations of the inconsistency revealed by these figures are that the SRS has recorded too low a level of mortality for women or that a higher fraction of females was omitted from the 1971 than from the 1961 census. The indirect estimates of death registration completeness described in Chapter 2 suggest that, in fact, female deaths were less completely recorded than male deaths by some 6 percent in the SRS. The abrupt increase in sex ratios (M/F) in the 1971 census, followed by a decline between 1971 and 1981, suggests that females were in fact differentially omitted in the 1971 census. It will also be recalled from Chapter 1 that the 1971 Post Enumeration Check discovered higher female than male net omission from the 1971 census. It was estimated that 1.53 percent of males and 1.83 percent of females were omitted; however, the age patterns of omission were also different. Of the omitted females, 16.7 percent were over age 45, versus only 9.8 percent of males. The female omission rate rises with age from 0.84 percent at ages 35-44 to 1.46 percent at ages 45-59 and 2.35 at age 60+. This pattern, even if it were constant over censuses, would imply poorer adult survival from intercensal comparison than actually prevailed. The estimated omission rate for males actually declined with age from 1.04 percent at ages 35-44 to 0.81 percent and 0.77 percent at the two higher age groups. One possible reason for the higher female underenumeration with age is differential omission of single-person households.

We believe that some combination of the two explanations--female death omission from the SRS and female omission from the 1971 census--is probably operative, but available data and procedures make choosing the exact combination an act of specualtion.[5] The final column in Table 38 shows what the ratios of actual to projected population would be if SRS female deaths by age were inflated by 10 percent and if the 1971 count of females by age were raised by the factor 1.008, thereby placing the sex ratio in 1971 about halfway between those in 1961 and 1981.[6] This combination of corrections raises the mean of the first six ratios to .995 and of the first eight to .997. It also produces an age sequence of ratios that is quite similar in general configuration to the male sequence shown in Table 38. The latter consideration is

TABLE 38 Intercensal Survival Analysis Using SRS Death Rates 1969-71 to Project Forward the 1961 Population to 1971: All-India

Age in 1961	1961 Census Population (in 1,000) (1)	Estimated SRS 10-Year Survival Rates (2)	1961 Population Survived Forward (3)=(1)x(2)	Population in Column 3 Cumulated from Bottom (4)	1971 Census Population Cumulated (5)	Ratio, Actual to Projected (6)=(5)/(4)	Ratio, Actual to Projected if Death Rates Inflated by 10% 1971 Census Count, Inflated by 1.008 (7)
Males							
0-4	33,201	0.85214	28,292	200,965	201,618	1.003	--
5-9	33,088	0.97147	32.144	172,672	165,117	0.956	--
10-14	26,286	0.97607	25,657	140,529	139,890	0.995	--
15-19	18,606	0.97164	18,078	114,872	118,312	1.030	--
20-24	18,206	0.96696	17,604	96,794	97,969	1.012	--
25-29	18,540	0.96009	17,800	79,189	79,644	1.006	--
30-34	15,994	0.94580	15,127	61,389	62,404	1.016	--
35-39	13,609	0.92132	12,538	46,261	47,343	1.023	--
40-44	12,091	0.88336	10,681	33,723	34,873	1.034	--
45-49	9,740	0.83137	8,098	23,042	23,755	1.031	--
50-54	9.135	0.75919	6,935	14,945	16,877	1.129	--
55-59	5,286	0.66646	3,523	8,010	9,391	1.172	--
60-64	5,709	0.51221	2,924	4,487	5,746	1.281	--
65-69	2,474	0.36406	901	1,563			
70+	4,179	0.15840	662	662			

Females

0-4	32,928	0.83389	27,458	188,504	184,942	0.981	1.000
5-9	31,612	0.96546	30,520	161,046	152,660	0,948	.965
10-14	23,040	0.96418	22,214	130,525	130,409	0.999	1.017
15-19	17,290	0.95595	16,528	108,311	108,876	1.005	1.025
20-24	19,141	0.95201	18,222	91,783	88,390	0.963	.983
25-29	18,056	0.94781	17,114	73,560	70,519	0.959	.981
30-34	14,860	0.94275	14,009	56,446	54,853	0.972	.996
35-39	11,865	0.93286	11,068	42,437	41,620	0.981	1.009
40-44	10,779	0.90744	9,781	31,369	31,200	0.995	1.028
45-49	8,327	0.86840	7,231	21,588	21,783	1.009	1.049
50-54	7,983	0.80582	6,433	14,356	15,830	1.103	1.156
55-59	4,551	0.71541	3,256	7,924	8,939	1.128	1.199
60-64	5,535	0.55213	3,056	4,668	5,581	1.196	1.284
65-69	2,380	0.38778	993	1,612			
70+	4,445	0.15495	689	689			

not immaterial in determining the combination of death/census omission since adopting a higher assumed level of death omission and lower level of census omission raises the actual/expected ratios at older ages and lowers them at younger ages. That the female sequence in the final column of Table 38 is brought into close alignment with the male is thus evidence, albeit weak, that a satisfactory combination of female omissions has been found.

If the 1971 census count of females should be raised by 0.8 percent to make it comparable in completeness to the 1961 census, then our earlier intercensal survival analysis has somewhat overestimated the level of female mortality during 1961-71. However, the adjustment is neither sufficiently large (less than 1 year of life expectancy at birth or age 5) nor sufficiently well justified to cause a recasting of earlier results. Note that a revision would not affect the estimated intercensal birth rate. Adding 0.8 percent to the 1971 census population would increase the average annual female intercensal growth rate by .0008 and reduce the female intercensal death rate by a like amount.

3.2 DECADE OF 1971-81

As noted above, the 1981 age distribution from a 5-percent sample of the total population became available as this volume was going to press (India, Registrar General, 1983c). Due to its significance as an independent check on the SRS based estimates, we performed an intercensal survival analysis for all-India (exclusive of Assam which was not included in the 1981 census owing to disturbed conditions).

We employed two methods recently developed as offshoots of the generalization of stable population relations. The first is a method, due to Preston and Bennett (1983), for estimating adult mortality that makes use of a simple relationship existing in any closed population between the ratio of populations at two ages at any moment, the probability of survival between those ages, and the growth rates between those ages. The advantage of the method is that the only data needed are age distributions from two censuses, and it requires neither the assumption of stability nor the adoption of an age pattern of mortality from a model life table system. The second method, the integrated procedure developed by Preston (1983) that builds on the Brass logit life table system (Brass, 1975) and generalized stable population equations, amalgamates an independently derived estimate of child mortality with the age distributions from two successive censuses in arriving at an estimated birth rate and level of mortality. The birth rate in this method in inferred from the intercept of a line fitted to data points, while the slope determines the level of adult mortality.

Since the age-sex distributions were not available, the above analysis could not be carried out by sex. Though not required under the methods, we treat India's population as essentially closed to migration. There were, however, speculations about large-scale immigration into the country during 1971-81 (e.g., Mukerji, 1982). If it took place, such migration went largely undisclosed in the census since the reported number of foreign-born persons in the country, exclusive of Assam, declined from 8.121 million in 1971 to 7.938 million in 1981 (India, Registrar General, 1983c).

In Figure 6 we plotted the ratios of the estimates of life expectancy for ages 5-55 derived from the application of the Preston-Bennett procedure to the corresponding values in the West model life table of level 15. For ready comparison, also presented are the ratios obtained by application of the procedure to the 1961-71 and 1951-61 intercensal periods. The variations in the level of mortality implied by the life expectancy values at various ages are remarkably similar in the three intercensal periods; they undoubtedly arise from the idiosyncrasies in age misreporting in India. But the figure also seems to establish the fact that, over time, life expectancy rose almost uniformly at every age. Between 1961-71 and 1971-81, the proportionate increases in the life expectancy at ages 5-55 fall in the range of 9-13 percent, and between the preceding two intercensal periods they lie in the neighborhood of 12-18 percent. Given the quality of the data, these are surprisingly narrow intervals of variation. The mean of the ratios shown in Figure 4 for the 1971-81 period is 1.047, implying a life expectancy at age 5 (e_5) of 60.2 years, while the corresponding estimate for 1961-71 is 54.1 (compared with 54.8 years estimated from the forward projection method in Section 3.1) and 46.9 years for 1951-61. Thus, the fears about a premature slowing down of mortality transition in India are not supported by intercensal analysis.

In applying the integrated method, we experimented with two standard life tables and three values of child mortality. The standards chosen are the South model life

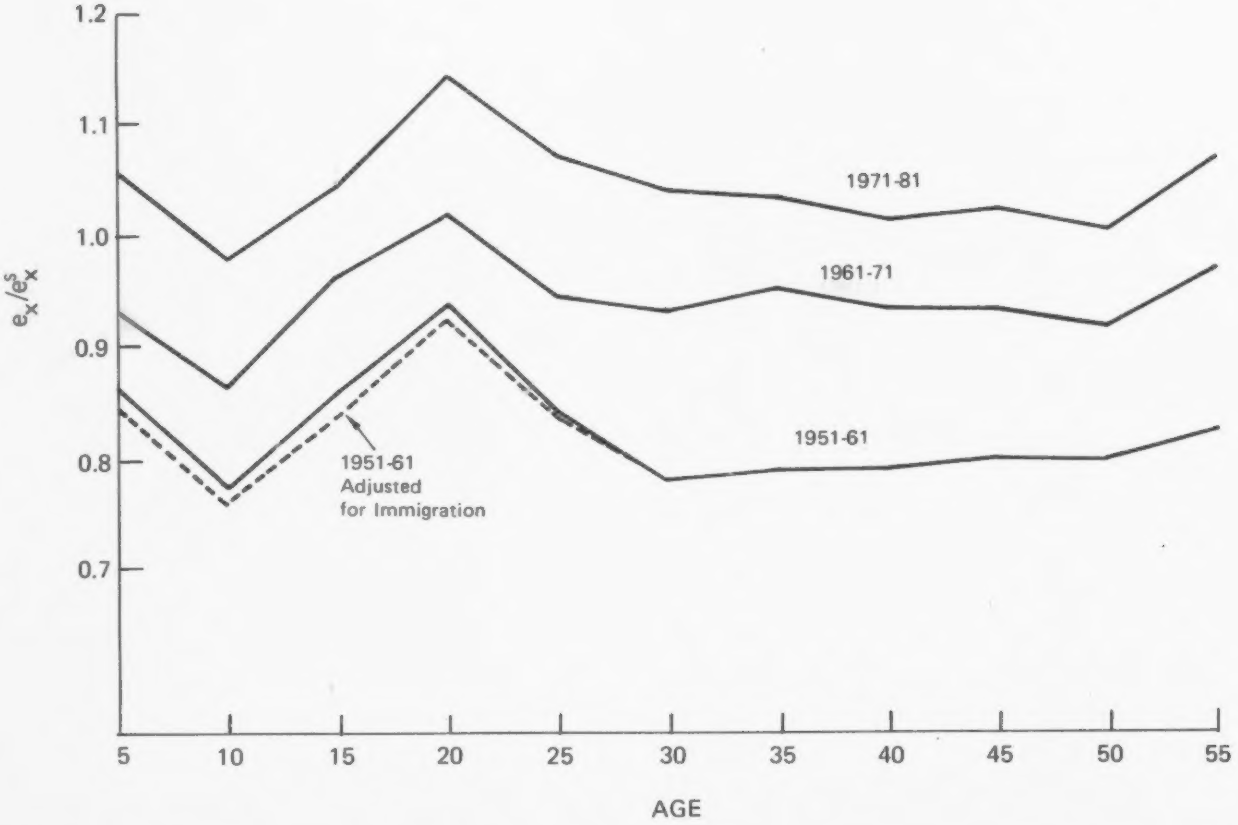

FIGURE 6 Ratios of Estimates of Life Expectancy at Various Ages to Corresponding Values in West Model Life Table, Level 15

table of level 15 and a life table with an e_0 value of 50 belonging to South Asian family of the new U.N. model life table system (United Nations, 1982). The South Asian model, constructed with SRS tables as a main ingredient, show extremely low mortality in the age range 10-50 and unusually high values outside this range. Among the Coale-Demeny tables, life tables belonging to the South family show similar, but smaller, deviations.

As discussed in Chapter 2, there was poor agreement between the 1979 survey estimates of child mortality and those based directly on the SRS. Hence, in applying the method, we tried three values of p(5), the probability of surviving to age 5. They correspond to the graduated q(2) of 0.125 from the 1979 survey, the raw q(2) of 0.143 from the same survey, and a death rate under age 5 of 51.0 per 1,000 from the SRS for 1976. These were converted into p(5) values via the South model life table system. The estimates of various demographic parameters resulting from the above combinations are given below. In all cases, estimates were derived by fitting a line to data points for ages 5-30 and 35-55, using the grouped mean procedure:

Standard Life Table	p(5)	BR	DR	e_0	e_5
South,	.854	34.3	12.1	56.9	61.5
Level 15	.830	35.3	13.1	55.4	61.5
	.788	37.2	15.0	52.6	61.5
South Asia,	.854	34.3	12.1	55.5	59.8
e_0 = 50	.830	35.4	13.2	54.0	59.8
	.788	37.3	15.1	51.3	59.8

As would have been expected, the choice of the standard life table did not affect the estimated birth rate, while that of adult mortality was somewhat sensitive to the choice. Even so, the estimates of e_5 show a narrow range of variation (59.8-61.5) into which the estimate calculated from the Preston-Bennett technique also fits nicely. But the estimate of the birth rate shows considerable variation with the assumed value of child mortality (as does the death rate computed by subtracting the intercensal growth rate from the birth rate estimate). However, it is possible to narrow down the range. It is unlikely that the child death rates from the SRS and the estimates of e_5 from the intercensal analysis are simultaneously correct, since together they would imply an implausible age pattern of mortality, with extraordinarily high child mortality. As we have seen in Chapter 2, the e_5 values computed from the unadjusted SRS death rates for the mid-1970s were around 58 years. On the other hand, the graduated q(2) of 0.125 from the 1979 survey is probably too low as it implies incredibly high overestimation of child mortality in the SRS. Also, as pointed out in Chapter 2, the graduated q(2) value is probably affected by the underreporting of dead children by older women in the 1979 survey. Thus the raw q(2) from the 1979 survey seems to provide the most satisfactory set of demographic measures for the 1971-81 decade if both of the censuses were more or less equally complete. Accordingly, we conclude that, on the basis of intercensal analysis at least, the birth rate was 35-36 per 1,000 and e_0 was 54-55 years during the past decade.

NOTES

1. The South model mortality pattern was employed throughout the intercensal analysis. The standard life table used was computed from male and female South life tables at level 11 using the equation: lx = (1.05lxm + lxf)/2.05. Given that the value of l2 was fixed, a value of β (the level parameter in the two-parameter model life table system) could be calculated for each value of β. Together, the α and β values were applied to the standard South life table to generate the life tables incorporating a wide range of relationships between adult and child mortality.
2. For details of the adjustments that were made to allow for both changes in state territorial jurisdiction and migration see Dyson (1979b).
3. The age-specific fertility rates for a state used in this procedure were those for that state in the 1972 Fertility Survey (see India, Registrar General, 1976b), after adjustment for the half-year age displacement in this source. These rates were applied to the unadjusted average number of women in each age group over the 1961-71 period by state to estimate the average annual births over the decade if the all-India rates had prevailed. The ratio of "actual"

birth rates from Table 36 to expected rates is then applied to the states' total fertility rate to yield the figures in columns 5 and 6.

4. The 1969 age-sex-urban-rural specific death rates are taken from India, Registrar General (1972c). Rates for 1970 and 1971 are taken from India, Registrar General (1975b, 1977d). For each age, urban and rural figures are weighted by urban and rural proportions for all-India as recorded in the 1971 census.

   These age-specific rates were converted into 10-year survival proportions for the population aged x to x + 5 at the first census by the formula

   $$\exp\left[\,-(2.5\,{}_5M_x + 5\,{}_5M_{x+5} + 2.5\,{}_5M_{x+10})\,\right].$$

   For the interval starting at ages 65-70 the survival proportion was

   $$\exp\left[\,-(2.5\,{}_5M_{65} + 7.5\ M_{\infty 70})\,\right].$$

   For the open-ended interval starting at age 70 in 1961, the survival proportions were developed by reference to model stable populations. The model used was South with $r = .0225$ and level 13 for males and 10 for females (for more details, see Preston et al., 1979).

5. Inconsistencies between intercensal population change and SRS female mortality may also arise because the SRS figures pertain to the end of the decade, whereas intercensal experience is centered on 1966. A sharp decline in female mortality could account for some of the discrepancy. The fact that the census ratio of males to females actually rises substantially casts some doubt on the existence of a female-dominated mortality decline, and we know of no other information that would corroborate it.

6. The survival rate from 70+ to 80+ was left unchanged because it was not a product of the SRS data. All other survival rates in Table 38 were raised to the power 1.1111.

4 INTEGRATION OF ESTIMATES

This chapter draws together estimates appearing at different points in this report, with the aim of identifying and resolving inconsistencies and of producing a final assessment of India's vital rates.

4.1 CRUDE BIRTH RATES

Table 39 displays the various series of estimates of crude birth rate that have been produced. They reflect an extremely wide variety of procedures, and as a result what appear to be trends may simply reflect the differential impact of error, widespread in Indian data, on the results of the various techniques.

In this regard it is reassuring to note that there is a very high correlation among the various series. States in northern India--Rajasthan, Haryana, Uttar Pradesh, Assam, and Madhya Pradesh--have birth rates above the mean in each of the five series. The southern-most states--Kerala, Tamil Nadu, Karnataka, Maharashtra, and Andhra Pradesh--are below the mean in each of the five series. Bihar resembles the northern group in the three series in which it reliably appears; Gujarat also leans in the northerly direction. Orissa and West Bengal, forming a contiguous area in East India, show no persistent deviation from the all-India averages. Only Punjab violates the north/south dichotomy, being a below-average state in each of the five series by about 4-5/1,000. The regional picture appears remarkably clear in view of the extraordinary diversity of procedures and data used: census age distributions combined with survey estimates of child mortality (columns 1 and 2); fertility survey questions on births in the previous year and

TABLE 39 Summary of Crude Birth Rate Estimates: Selected States and All-India

State	1961-71 from Intercensal Analysis, Mean of Reverse and Forward Survival	1966-71 Reverse Survival from Adjusted 1971 Census	1971-72 from P/F Applied to 1972 Survey	1976 from Adjusted Deaths Plus Inferred Growth Rate	1979 from the SRS, Corrected by State-Specific Incompleteness Estimate for 1971-72
	(1)	(2)	(3)	(4)	(5)
Andhra Pradesh	38.4	40.1	36.7	35.1	34.0
Assam	46.6	44.0	43.4	40.7	38.3
Bihar	41.0	42.0	(33.2)[a]	n.a.	38.4[b]
Gujarat	41.4	39.2	42.0	42.5	38.3
Haryana	44.0	44.4	43.3	41.0	39.9
Karnataka	39.3	36.4	35.9	36.7	33.2
Kerala	34.8	34.5	32.6	35.2	27.6
Madhya Pradesh	45.0	46.7	40.8	41.3	39.8
Maharashtra	39.1	39.8	35.2	35.8	30.6
Orissa	42.3	39.8	39.6	35.4	36.2
Punjab	35.1	35.5	35.9	36.4	30.9
Rajasthan	43.8	43.8	42.3	43.7	36.9
Tamil Nadu	36.8	37.5	35.4	34.1	32.2
Uttar Pradesh	44.0	44.7	44.5	42.8	40.2
West Bengal	40.5	40.7	n.a.	n.a.	32.7[b]
All-India	40.9	41.2	39.3	39.1[c]	36.0

Note: n.a. = not available.

[a] Believed too low, adjusted in all-India figures.
[b] Unadjusted figure for the new sample area, 1979.
[c] Excludes Bihar and West Bengal.

parity (column 3); age distributions of population and deaths by age in the SRS (column 4); and SRS births corrected by estimates of underregistration (column 5).

Because the five series are derived in different ways, it is dangerous to infer trends by comparing them. Nevertheless, there is a good deal of interest in knowing the course of Indian crude birth rates, and we cannot avoid comment. The general indication from Table 39 for all-India is one of a slow decline in birth rates of about 2/1,000 from about 1966 to 1976, followed by a faster decline thereafter. This pattern is roughly consistent with the performance of family planning programs (Visaria and Visaria, 1981), and the acceleration coincides with the emergency-related intensification of population control measures in 1976. However, this timing pattern is not consistent with that of SRS crude birth rates (Table 24), which show a decline of about 2.5 between 1971 and 1976, followed by a decline of 1.3 between 1976 and 1979. The impression from the SRS is one of a relatively steady pace of decline during the 1970s (except for 1973 and 1974, when SRS performance deteriorated). The two series could be reconciled if the Table 39 estimate for 1975-76 were lowered by about 1.5 points, and it seems likely that the original estimate is biased upward by declining mortality (or possibly fertility), as seems evident for Kerala.

State birth rate trends are also subject to method-specific error. Nevertheless, a clear impression emerges from Table 39 that all regions have shared roughly equally in the birth rate decline, although they started from different levels. This impression is confirmed in Table 40. There is no substantial difference in the pace of decline among the northern, southern, and intermediate groups of states. Of course, there is no assurance that the same factors underlie the trends in various regions. For example a larger fraction of the decline in the north may be attributable to the larger declines in child mortality, and their associated age distributional disturbances, that occurred there. It is also possible that SRS completeness deteriorated during the 1970s in the north relative to other regions. A state-specific analysis of intercensal growth 1971-81 presented below indicates that, in Rajasthan and Uttar Pradesh, growth did not decelerate as much as is implied by SRS figures.

Not shown in Table 39 is our estimated CBR for all-India based on intercensal analysis for 1971-81. The decadal value of 35.3 (using South Asia life tables and a

TABLE 40 Changes in Mean Crude Birth Rates in Groups of States Between Approximately 1968 and 1978: All-India

	Mean Crude Birth Rate 1961-71, 1966-71, 1971-72	Mean Crude Birth Rate, 1975-76, 1979	Approximate Decadal Decline
High Fertility, North (6)			
Assam, Bihar, Haryana, Madhya Pradesh, Rajasthan, Uttar Pradesh	43.66	39.97	3.69
Low Fertility, South (5)			
Andhra Pradesh, Karnataka, Kerala, Maharashtra Tamil Nadu	38.83	33.45	3.38
Others and Intermediate (4)			
Gujarat, Orissa, Punjab, West Bengal	39.39	35.64	3.75

Source: Table 39.

q(2) = .143) is inconsistent with the value of 36.0 for 1979 that assumes SRS completeness to have been constant from 1971-72 to 1979. It seems likely that SRS completeness improved during the decade, implying that SRS declines in birth rates have underestimated the declines that have actually occurred. Alternatively, we may have underestimated completeness by up to five percentage points for 1970-73. We believe that the intercensal figures for all-India are more reliable in view of the multitude of errors that could have crept into SRS and our analysis of its completeness: deficient population bases for computing vital rates; national unrepresentativeness of SRS; errors in age reporting that would affect completeness estimates; small numbers of events in the age-state data cells that are the basis of completeness estimates; errors in published data (which appear to be prominent in India), and so on.

The intercensal figures are not themselves free of error. A more refined intercensal analysis based on a simulation of "true" demographic conditions, presented below, produces a somewhat higher intercensal CBR that is more consistent with our corrections of SRS data, and it yields what we consider to be the best estimate of all-India birth rates for 1971-76 and 1976-81.

4.2 TOTAL FERTILITY RATES

Estimates of total fertility rates are less reliable than those of crude birth rates because they require information on the age pattern of fertility as well as on its volume. As discussed above, age reporting in India is not accurate by international standards. In addition, there is only one source of information about the age pattern of fertility by state, the 1972 Fertility Survey. The 1979 survey provided figures at the national level. The figures resulting from analysis of these sources are repeated in Table 41 as are the implied total fertility rates based on indirect standardization of crude birth rates in the 1961-71 decade.

The level and trend in TFRs shown in Table 41 are somewhat different from those derived by other analysts who have examined the same data. Both the all-India estimates for 1971-72 and that for 1979 are below the levels previously estimated, by .2-.5 children per woman. The reasons we take issue with previous studies are described in Chapter 2. In addition to differences in technique, there were differences in data availability. We had last-minute access to the 1981 census age distribution, which encouraged us to reduce fertility estimates when uncertainties arose (as they did, particularly in the case of Uttar Pradesh).

The upshot is that we estimate that fertility has declined more than is generally believed. We calculate the decline to be slightly more than one child per woman between (approximately) 1966 and 1978.

4.3 CRUDE DEATH RATES

The two major sources of estimates for the crude death rates are intercensal analysis for the 1961-71 decade and death rates produced by the SRS since 1970, corrected for estimated underregistration. These figures are presented in Table 42. In the case of the SRS estimates, the completeness is assumed to be .9 throughout the decade and in each state, and rates presented in the SRS Bulletins

TABLE 41 Summary of Total Fertility Rate Estimates: Selected States and All-India

State	1961-71: Total Fertility Rate Based on Intercensal Analysis, Mean of Forward and Reverse Projected Procedures, Indirect Standardization for a State Using 1971-72 as Standard	1971-72: Based on P/F Applied to 1972 Fertility Survey	1978: Based on Intersurvey Comparison 1972-79 of Parity and Births Last Year
Andhra Pradesh	5.01	4.80	
Assam	6.85	6.35	
Bihar	5.62	(4.75)[a]	
Gujarat	5.83	5.97	
Haryana	6.91	6.64	
Karnataka	5.51	5.50	
Kerala	4.70	4.49	
Madhya Pradesh	6.40	6.16	
Maharashtra	5.29	4.92	
Orissa	5.72	5.54	
Punjab	5.52	5.57	
Rajasthan	6.34	6.38	
Tamil Nadu	4.66	4.58	
Uttar Pradesh	6.45	(6.89)[b]	
West Bengal	5.93	n.a.	
All-India	5.72	5.60	4.69

Note: n.a. = not available.

[a] Believed too low, corrected in the all-India figures.

[b] Believed too high, set at 6.45 for all-India figures.

TABLE 42 Crude Death Rates Estimated from Various Sources: Selected States and All-India

State	1961-71 from Reverse Survival	1961-71 from Forward Survival	Adjusted Estimates from the SRS		
			1970-73	1974-76	1977-79
Andhra Pradesh	19.9	18.7	17.5	16.6	14.9
Assam	18.0	16.7	(19.0)	(18.0)	13.9
Bihar	22.3	19.5	--	--	16.8[a]
Gujarat	15.8	16.1	17.9	16.2	15.0
Haryana	16.9	16.3	(12.0)	14.0	14.0
Karnataka	18.1	17.4	14.0	12.4	12.4
Kerala	9.4	11.3	10.0	9.0	7.8
Madhya Pradesh	21.5	19.6	18.8	18.8	17.8
Maharashtra	16.6	15.9	14.1	12.7	12.6
Orissa	20.6	20.3	19.5	18.3	16.9
Punjab	14.5	13.9	12.9	12.0	12.0
Rajasthan	18.6	17.8	18.4	16.6	16.0
Tamil Nadu	15.8	17.0	16.4	16.1	14.3
Uttar Pradesh	26.0	23.8	24.1	23.3	20.6
West Bengal	17.1	17.4	--	--	13.4[a]
All-India	19.1	18.4	17.8[b]	16.9[b]	15.5[b]
All-India (except Bihar and West Bengal)			17.7	16.8	15.4

Note: Figures of questionable validity are in parentheses.

[a] 1979 only, from new sample areas, corrected by assuming 10 percent underregistration.

[b] All-India results without Bihar and West Bengal are raised by 0.1/1,000, the mean of the effects of including thee areas in 1979 (new sample areas) and in the two 1961-71 intercensal estimates (state-weighted).

are thus divided by .9. The lack of demonstrable interstate differences (except for Bihar and West Bengal) was suggested in Chapter 2.

Combining the two basic procedures produces a picture of smoothly declining crude death rates for all-India. The mean of the two intercensal procedures for 1961-71 is a crude death rate of 18.75; according to adjusted SRS figures, this rate declined to 17.8 in 1970-73, to 16.9 in 1974-76, and to 15.5 in 1977-79.

The juxtaposition of the two data series for states in Table 42 creates little disjunction. The series are highly correlated with one another, as in the case of crude birth rates. Uttar Pradesh, Madhya Pradesh, Bihar, and Orissa are the highest-mortality states in the intercensal analysis, just as they are in 1977-79. Kerala and

Punjab are the lowest-mortality states in all series. So there is a north/south gradient in mortality, as in fertility, but it differs in some major respects. Orissa in East India, intermediate in fertility levels, clearly belongs with the high-mortality northern group. Haryana, in the high-fertility northern group, is closer to neighboring and exceptional Punjab in its low crude death rate.

The SRS crude death rates of most questionable validity are those for Assam in 1970-73 and 1974-76. Both numbers are substantially higher than the intercensal figures or than figures for 1977-79. It may be recalled that Assam was estimated to have 17-percent overregistration of deaths by the Brass and Preston-Coale procedures for the period 1970-76; something seems clearly amiss with these figures, but it is not at all clear what the problem may be. The Haryana figure for 1970-73 seems too low; the recorded crude death rate was increasing during this period, presumably as registration completeness was improving.

As in the case of crude birth rates, there is relatively little regional differentiation in death rate trends. The three states with the largest declines in crude death rates in Table 42 (comparing the far left and far right columns) are Andhra Pradesh, Uttar Pradesh, and Karnataka. These are three of the five states that had an acceleration in intercensal growth between 1961-71 and 1971-81. This correspondence not only helps to confirm the validity of estimated trends in crude death rate but also suggests the important role of changing death rates in accounting for changing of patterns of regional growth.

As in the case of the crude birth rate, our 1971-81 intercensal analysis in Chapter 3 produces a lower crude death rate (13.2 per 1,000) for the decade than is implied by our correction of SRS figures. Once again, the refined intercensal analysis based on simulations presented below produces an intermediate figure that we accept as most reliable.

4.4 CHILD MORTALITY

The various estimates of child mortality were thoroughly described and compared in Chapter 2 and there is no independent set of estimates emerging from other sections of the report. The most important summary tables in that section are Tables 11 and 17. Analysis and evaluation of two surveys asking questions on children ever born and children surviving indicate that the all-India q(2)--the proportion of live births dying before age 2--had declined from .225 in 1961 to .164 in about 1968. This major reduction in mortality must have led to a substantial growth acceleration, which would have affected intercensal growth in 1961-71 relative to 1971-81, since the lower level would have pertained throughout the later decade but for only part of the earlier one.

There is less solid ground for estimating the trends in all-India child mortality since 1968. A 1979 survey produced an estimated q(2) of .125 which would pertain approximately to 1975. But the implied continued rapid decline in child mortality between 1968 and 1975 is not confirmed by the SRS data on infant mortality rates or on death rates below age 5 in the first half-decade of the 1970s (see Table 7). The latest age-specific death rates published by the SRS are for 1977, and they show a death rate below age 5 ($_5M_0$) of 50.9/1,000 (India, Registrar General, 1980b:12). The $_1q_0$ in the SRS life table for 1976-77 is .131. Both figures pertain to all-India except Bihar and West Bengal. Equivalent figures for the SRS in 1970-72 are 54.6 and .132 (unpublished data supplied by the Registrar General). This is only a 7-percent decline in $_5M_0$, compared with an implied 24-percent decline in q(2) from intersurvey comparisons. The high level of child mortality shown in SRS is called into question in Chapter 3, where it is shown to imply (when compared with apparent intercensal adult mortality conditions) an anomalous age pattern of mortality. The inconsistency between these sources is further addressed below by examining the degree to which their implications agree with intercensal growth and age distributional changes.

4.5 LIFE EXPECTANCY

The two basic sources for computing life expectancy are intercensal analysis combined with child mortality estimates and direct use of age-specific death rates from the SRS. Because very small numbers of deaths are involved at most ages in the SRS state data, we have not attempted to make life expectancy estimates by state from the SRS data. The 1961-71 life expectancy estimates by state are shown in Table 35.

The all-India results are presented in Table 43. In three columns we have presented life expectancy values after correction of all SRS age-specific death rates above age 5, assuming in accordance with analysis in Chapter 2 that registration of female deaths was 87-percent complete and that of male deaths was 93-percent complete.[1]

For life expectancy at age 5, the agreement between SRS and intercensal analysis is reasonably good. The life expectancy of 59.8 for the latter is within two years of the (two-sex mean) of uncorrected SRS figures for 1971 and 1977 and within 3.5 years of the corrected SRS figure. The period 1972-73 was one of economic distress in India and estimates for this period are further from the intercensal average. It should be remembered that a large mortality improvement occurred in 1979 and 1980 that is not reflected in the SRS figures in Table 43.

A larger disparity of 4-6 years occurs in the case of life expectancy at birth. This increase in the disparity simply reflects the fact that we have used a survey-based estimate of child mortality for intercensal analysis that is substantially lower than that contained in the SRS. We conclude below that the bulk of evidence supports the lower, survey-based figure.

The SRS-based life tables exclude Bihar and West Bengal. Judging from a comparison of state-weighted intercensal estimates with and without these states (based on Table 35 in Chapter 3), including these states would lower e_0 by 0.05 years for males and 0.20 for females.

4.6 COMPARISON OF ESTIMATED LEVELS OF CRUDE BIRTH RATES AND DEATH RATES TO INTERCENSAL GROWTH, 1971-81

As noted earlier, the intercensal growth rate (continuously compounded) between the 1971 and 1981 censuses was .0222.[2] Since there is little international migration in India, relative to its size, this figure should be close to the difference between crude birth and death rates during the intercensal period. It may differ if either birth rate or death rate estimates are erroneous or if the intercensal growth rate is distorted by differential completeness between the two censuses.

For purposes of this comparison, birth and death rates used for the intercensal period will be those for 1971-80. The mean SRS unadjusted crude death rate for all-India

TABLE 43 Life Expectancy Estimates from Various Sources: All-India

	Intercensal Analysis	Based on Uncorrected SRS Data[a]			Based on Corrected SRS Data, Assuming Above Age 5 Female Completeness of .87; male of .93[a]			Based on 1971-81 Intercensal Analysis
	1961-71	1971	1972-73	1977	1971	1972-73	1977	1971-81
Life Expectancy at Birth								
Male	46.8	50.2	48.9	50.7	49.3	48.1	49.8	54.0
Female	45.3	49.4	47.1	49.4	47.7	45.4	47.6	
Life Expectancy at Age 5								
Male	55.4	57.9	56.8	58.0	56.8	55.8	57.0	59.8
Female	53.7	58.4	56.6	58.3	56.2	54.4	56.1	

[a] Excludes Bihar and West Bengal.

(except Bihar and West Bengal) in 1971-80 is 14.68 (including an actual figure for 1980 not presented in Table 18). The estimated registration completeness for this area is .90, so the corrected death rate is 16.3.

The mean SRS crude birth rate from 1971-80 for all-India (except Bihar and West Bengal) is 34.49. Survey-based estimates in Chapter 2 indicate that birth registration was about 7.8-percent deficient in 1970-73, and we assume that this is constant during the decade; the corrected crude birth rate is 34.49/.922 = 37.4. This figure implicitly adopts the timing pattern of SRS birth rate declines.

Thus, the difference between intercensal birth and death rates implied by the estimates and procedures used in this report is 37.4 - 16.3 = 21.1 per 1,000. If, as we have estimated, approximately 0.8 percent of females were omitted from the 1971 census relative to censuses of 1961 and 1981, then the true intercensal growth rate should have been .0218.

Our estimates of decadal birth and death rates have thus underestimated observed population growth by about 0.7 per 1,000. While net inmigration from Pakistan and Bangladesh may account for some of the disparity, it seems likely that we have either slightly underestimated birth rates or slightly overestimated death rates, or both.

Similar comparisons are made for major states in Table 44. The mean SRS unadjusted crude birth and death rates for 1971-80 are computed from the annual figures presented in Tables 18 and 24. Since rates for 1980 were not available, 1979 figures are repeated for 1980. As in the case of the all-India procedure, estimates of SRS completeness for the early years of the 1971-80 decade are assumed to pertain throughout the decade. The state estimates of completeness of birth registration in SRS are taken from Table 31. The conclusion from Chapter 2, Section 2.2, was that there was relatively little demonstrable variation among the states in the completeness of death registration, so the all-India estimate of 90-percent completeness is used in correcting recorded death rates of each state. One exception to this procedure, however, occurs in Assam. The application of both the Brass and the Preston-Coale techniques had suggested considerable overreporting of deaths in that state, though operational reasons for this are not known. Incorporated in Table 44 for this state is its unadjusted SRS death rate.

TABLE 44 Comparison of Estimated Levels of Crude Birth and Death Rates with Intercensal Growth Rates for 1971-81: Selected States of India

State	Corrected Mean SRS Crude Birth for 1971-80[a]	Corrected Mean SRS Crude Death for 1971-80[a]	Estimated Crude Rate of Natural Increase for 1971-80	Intercensal Growth Rate for 1971-81	Intercensal Growth Rate for 1961-71	Estimated Crude Rate of Natural Increase for 1961-71[b]	Recorded Increase in Intercensal Growth Rate from 1961-71 to 1971-81	Estimated Increase in Crude Rate of Natural Increase from 1961-71 to 1971-80
	(1)	(2)	(3)=(1)-(2)	(4)	(5)	(6)	(7)=(4)-(5)	(8)=(3)-(6)
Andhra Pradesh	35.8	16.1	19.7	21.0	18.8	19.0	2.2	0.7
Assam	39.0	(15.0)	(24.0)	n.a.	29.6	28.8	n.a.	(-4.8)
Bihar	n.a.	n.a.	n.a.	21.7	19.2	20.1	2.5	n.a.
Gujarat	39.9	16.1	23.8	24.6	25.6	25.3	-1.0	-1.5
Haryana	41.3	13.3	28.0	25.5	27.7	27.1	-2.2	0.9
Karnataka	33.4	12.8	20.6	23.9	21.5	21.3	2.4	-0.7
Kerala	29.3	8.8	20.5	17.7	23.2	24.4	-5.5	-3.9
Madhya Pradesh	40.4	18.3	22.1	22.7	25.0	24.2	-2.3	-2.1
Maharshtra	32.6	13.1	19.5	22.1	24.1	22.6	-2.0	-3.1
Orissa	37.2	18.2	19.0	18.5	22.2	21.6	-3.7	-2.6
Punjab	33.5	12.2	21.3	21.6	19.5	20.8	2.1	0.5
Rajasthan	38.7	16.6	22.1	28.7	24.4	25.5	4.3	-3.4
Tamil Nadu	34.2	15.3	18.9	16.3	20.0	20.3	-3.7	-1.4
Uttar Pradesh	42.2	22.2	20.0	22.9	17.9	19.2	5.0	0.8
West Bengal	n.a.	n.a.	n.a.	21.0	23.6	23.0	-2.6	n.a.

Notes: Figures of questionable validity shown in parentheses; n.a. = not available

[a] As figures for 1980 were not available, rates for 1979 were repeated for 1980. For the method of correction for underregistration, see text.

[b] Estimated from intercensal growth rates for 1961-71 shown in column 5, and net migration rates shown in Table 33.

Source: India, Registrar General (1975a, 1982), and Tables 18, 24, 31, 33 of this report.

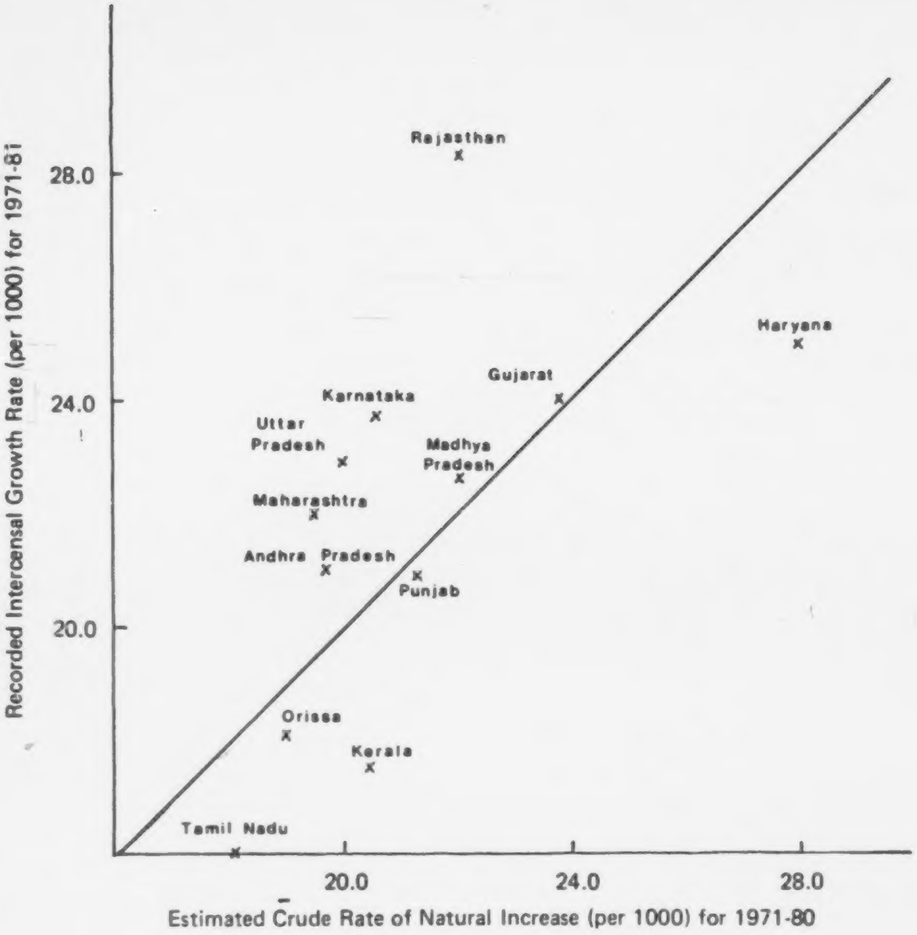

FIGURE 7 Comparison of 1971-81 Intercensal Growth Rates and Crude Rates of Natural Increase, by State

Column 3 of Table 44 provides the state estimates of crude rate of natural increase (per 1,000) for 1971-80 computed on the above basis. In Figure 7 these estimates are plotted against intercensal growth rates recorded for 1971-81. The results show a reasonable degree of consistency. The overall correlation between the two series is 0.61; when Rajasthan (where the estimate of crude rate of natural increase is 23 percent lower) is excluded, the correlation coefficient rises to 0.69. A less than perfect correlation may result from many sources: internal migration (reflected in intercensal growth but not in crude rates of natural increase); differential census coverage completeness; and errors in the estimated series of birth and death rates.

It is also useful to know how accurately our estimates of crude rate of natural increase can predict the observed changes in the intercensal growth rates from 1961-71 to 1971-81. The last two columns of Table 44 compare the recorded increase in intercensal growth rates from 1961-71 to 1971-81 with the estimate of increase in crude rate of natural increase in the same period, state by state. In three states only--Rajasthan, Haryana, and Karnataka--do we incorrectly predict the direction of the trend in growth rates. Another glaring anomaly is Uttar Pradesh. The 1981 census reveals considerable more acceleration in growth rate than we "anticipate" for this state. The correlation between the two series is 0.47, but if Rajasthan is excluded it rises to 0.76. In Rajasthan, where unadjusted SRS birth rates have shown a sharp downward trend (2.2-percent average annual rate of decline during 1970-79 compared with the all-India figure of 1.3 percent) our assumption of constant SRS completeness is called into question., It is also possible in this state that immigration from Pakistan (Mukerji, 1982) and Haryana, and/or relatively better enumeration in the 1981 census, have contributed to the deviation of the observed growth rate from the one predicted. The SRS death rates for Haryana, especially those for the early 1970s, may have needed slightly higher correction for underreporting than the 10 percent assumed. Figures for Karnataka and Uttar Pradesh are probably affected by a mix of factors such as in-migration, changing completeness of birth registration in the SRS, and differential completeness of 1971 and 1981 censuses.

Thus, the overall agreement between estimates of crude rates of natural increase by state and intercensal growth rates can be described as fair to good, but far from perfect. There is evidently a good deal of room for error in either or both series, particularly in the two northern states of Rajasthan and Uttar Pradesh. The very large intercensal growth acceleration in these two states is not predicted by our estimated trends in vital rates. Elsewhere, however, the correspondence between the two series, and their changes, is quite good.

4.7 THE CONSISTENCY OF ESTIMATED AGE-SPECIFIC RATES WITH OBSERVED TRENDS

The growth in population between the 1971 and 1981 censuses is reasonably consistent with the estimated trends in crude rates of birth and death. But these crude rates provide only indirect support for the sets of age-specific rates with which they are associated. Age misreporting has no effect on crude rates in the SRS, for example, but it could and almost certainly does influence life expectancy based on SRS age-specific death rates.

In order to see whether our estimated age- and sex-specific rates are consistent with available external evidence, such as intercensal growth rates and sex ratios from the 1981 census, we performed a simulation exercise that uses our estimated age-sex rates as input. The simulation takes the form of a two-sex population projection in five-year increments of age and time. Female births are derived by combining assumed age-specific fertility rates with the estimated number of women by age. Male births are derived by assuming a sex ratio at birth of 1.05. The base point of the projection is March 1, 1966, approximately halfway between the censuses of 1961 and 1971. Zero net international migration is assumed. The main steps are the following:

1. Estimate the population age distribution by sex in 1966 using a procedure presented in Preston and Coale (1982). This procedure derives an age distribution entirely from data on age-specific growth rates, here assumed to be those observed between the 1961 and 1971 censuses, combined with the prevailing life table. The intercensal life table estimated in Chapter 3 is used for this purpose. The resulting age-sex distribution is shown in Table 45.

2. Age-specific fertility rates. From above, the estimated total fertility rate estimated for 1961-71 was 5.72, and for 1971-72 it was 5.60. The interpolated value of 5.668 was used for the 1966-71 period. Age-specific fertility rates recorded in the 1972 Fertility Survey were scaled to a TFR of 5.668 after they were corrected for the half-year age displacement present in birth-last-year reports. For the period 1971-76, age-specific fertility rates were interpolated between the corrected values for 1971-72 (TFR = 5.60) and 1978 (TFR = 4.69). The interpolated TFR is 5.366. For the period

TABLE 45 Estimated and Projected Age Distributions (in 1,000s) Based on Assumed Age-Specific Fertility and Mortality, 1966-81: All-India

Age at Start of Interval	1966		1971	
	Male	Female	Male	Female
0	40,502	37,878	44,862	42,456
5	33,521	31,391	37,951	35,179
10	28,487	26,650	32,895	30,739
15	23,907	22,565	28,086	26,203
20	20,702	19,998	23,454	22,023
25	18,793	18,176	20,231	19,426
30	17,174	16,213	18,329	17,616
35	15,101	13,882	16,671	15,652
40	12,939	11,757	14,555	13,349
45	10,976	10,004	12,344	11,221
50	9,239	8,466	10,246	9,369
55	7,565	6,901	8,369	7,729
60	5,839	5,289	6,562	6,006
65+	8,478	7,686	9,693	8,713
All-India	253,211	236,854	284,248	265,680
	1976		1981	
0	48,690	45,665	49,189	46,204
5	42,728	39,993	46,709	43,446
10	37,315	34,457	42,129	38,287
15	32,545	30,268	36,932	34,004
20	27,731	25,640	32,158	29,721
25	23,110	21,480	27,356	25,082
30	19,873	18,905	22,739	20,996
35	17,882	17,088	19,458	18,467
40	16,108	15,134	17,326	16,634
45	13,842	12,783	15,368	14,625
50	11,458	10,526	12,901	12,143
55	9,164	8,528	10,298	9,708
60	7,075	6,661	7,780	7,471
65+	10,758	9,823	12,215	11,634
All-India	318,278	296,951	352,558	329,421

1976-81, we used the adjusted values for 1978 from the 1979 survey. The calculations to obtain the age-specific fertility rates are shown below:

Age	1966-71	1971-76	1976-81
15-19	.1105	.1042	.0896
20-24	.2825	.2736	.2576
25-29	.2837	.2714	.2457
30-34	.2178	.2033	.1688
35-39	.1424	.1328	.1099
40-44	.0724	.0653	.0475
45-49	.0243	.0227	.0189
TFR	5.668	5.366	4.690

3. Life tables used. As noted above, there was an inconsistency between mortality levels indicated in the 1979 Survey of Infant and Child Mortality and the crude and age-specific rates derived from SRS in the latter part of the 1970s. The SRS child mortality rates are substantially higher. We have therefore used two variants for mortality, a high variant and a low variant:

High-Mortality Variant

1966-71. Mean of life table l_x values for 1961-71 and 1971. The 1971 life table is that of SRS for 1971, corrected above age 5 for .93 registration completeness for males and .87 for females. Parameters of these tables are shown in Table 43.

1971-76. Life table based on mean SRS age-specific death rates for the period 1971-75, after correction above age 5 for .93 registration completeness for males and .87 for females.

1976-81. The basis of the life table is the set of average age-specific death rates for SRS in 1976-78. These were scaled to agree with the crude death rate for the 1976-80 period in SRS. Rates above age 5 were then divided by .93 for males and .87 for females.

Low-Mortality Variant

1966-71. Mean of life table l_x values for 1961-71 and 1971. The 1971 life table is constructed by interpolating between the 1972 Fertility Survey estimate of q(2) = .164 and the 1979 survey estimate q(2) of .143 (after assignment of these values to their proper reference dates) and choosing the corresponding values of mortality under 5 in the South model life table system. The SRS sex differences in mortality below 5 are assumed to be correct. Above age 5, SRS age-specific death rates are divided by .98 for males and .92 for females. This procedure keeps the identified sex difference in mortality but reduces adult incompleteness to 5 percent.

1971-76. Below age 5, the interpolated values of q(2) between the 1972 and 1979 surveys is used to identify the appropriate mortality level in the South model life table system. Above age 5, SRS age-specific death rates for 1971-75 are divided by .98 for males and .92 for females.

1976-81. Below age 5, the extrapolated value of q(2) from the 1972 and 1979 surveys is used to identify the appropriate mortality level in the South model life table system. Above age 5, the same procedure is used as in the higher-mortality variant except that death rates above age 5 are divided by .98 for males and by .92 for females.

The values derived for the two variants are are presented below:

	1966-71		1971-76		1976-81	
	e_0	e_5	e_0	e_5	e_0	e_5
High Variant						
Male	48.1	56.1	48.7	56.3	51.3	57.7
Female	46.5	55.0	46.5	55.2	50.4	58.0
Low Variant						
Male	49.2	56.5	51.7	57.1	53.7	58.5
Female	47.7	55.4	49.7	56.0	53.1	58.9

TABLE 46 Principal Results of Demographic Parameters Using High- and Low-Mortality Variants and Compared with Values from the Sources: India

Parameter	High-Mortality Variant	Low-Mortality Variant	Value from Other Sources for 1971-81 Intercensal Period or for 1981
Growth Rate, 1971-81	20.1/1,000	21.5/1,000	22.2/1,000 (21.8/1,000 after correction for missing females in 1971
Crude Birth Rate, 1971-81	36.3/1,000	35.9/1,000	SRS = 34.5 uncorrected or 37.4 corrected for 7.8-percent under-registration
Crude Death Rate, 1971-81	16.2/1,000	14.4/1,000	SRS = 14.7 uncorrected or 16.3 corrected for 10-percent under-registration
Total Population Size, 1981	669.856*	681.979*	685.159 million (including estimate for Assam and adjustment for Jammu and Kashmir
Sex Ratio of Population, 1981	1.072	1.070	1.070 in 1981 census (excluding Assam)

*In millions.

Principal results of the two variants are presented in Table 46.

Despite the relatively small differences in mortality parameters between the two variants, there are approximately 12 million fewer deaths with the low-mortality variant between 1971 and 1981. The larger 1981 population produced by this variant, together with the faster implied rate of intercensal growth, clearly distinguishes it favorably from the high-mortality variant. Both figures are very close to those derived from the 1981 census. The implied 1981 sex ratio is also mildly in its favor when tested against the 1981 census. The low-mortality variant is also closer to uncorrected estimates of SRS crude birth and death rates for the period 1971-81. It implies that SRS crude birth rates are incomplete by 3.9 percent and that SRS crude death rates are too high by 2.0 percent (it was, of course, the inconsistency between survey results and SRS results for mortality that led us to create two mortality variants in the first place).

The only argument on behalf of the high-mortality variant is that it produces results closer to SRS crude birth rates and death rates after they are adjusted for estimated underregistration. But differences in CBRs are small (0.4 per 1,000) and differences in CDRs are meaningless since the high-mortality variant was constructed to include the 10-percent adjustment for estimated underregistration. So it is in no sense confirmatory when it produces results that are nearly identical to another series that is similarly adjusted. The main independent sources of information, the 1981 census and patterns of intercensal growth, give strong support to the low-mortality variant.

Table 45 presents estimates of the "true" age-sex distribution of India between 1966 and 1981 based on the low-mortality variant. The estimated age distribution for 1981 has a much lower proportion under 10 than in previous censuses, which is consistent with the sizable decline in fertility that we estimate to have occurred. In particular, the percentage below age 10 is estimated to have declined from 29.18 in 1971 to 27.21 in 1981. This decline compares to a reduction from 29.47 percent to 26.66 percent between the actual censuses of 1971 and 1981. Although we estimate a faster fertility decline than do other analysts (e.g., Jain and Adlakha, 1982), the census suggests that it may have been faster still (note, however, that estimated net omission rates under 10 rose slightly between 1971 and 1981).

The time sequence of vital rates estimated through the simulation procedure is shown in Table 47.

We believe that these figures, which incorporate many features from different parts of this volume, are the preferred demographic estimates for India from 1966 to 1981. Their one jarring implication is that SRS death reports are not incomplete; in fact, they may even be slightly too high, particularly as the decade of the

TABLE 47 Final Estimates of Vital Rates for Selected Periods, 1966-71 to 1976-81 All-India

Period	CBR	CDR	Rate of Natural Increase
1966-71	40.2	17.2	23.0
1971-76	37.9	15.5	22.4
1976-81	34.0	13.4	20.6
1971-81	35.9	14.4	21.5

1970s progresses. We believe further that SRS estimates of child mortality are too high by the last half of the decade. This very tentative conclusion would seem inconsistent with the Registrar General's belief that the SRS system was deteriorating slightly toward the end of the decade, unless the deterioration took the form of invented events or an increasingly incomplete population base. We have two additional observations on this subject.

First, as noted earlier, infant and below-5 mortality is overestimated to the extent that rounding ages upward deprives these age groups of their lowest-mortality segment. This tendency is strong in India; however, there is no reason to expect the tendency to have worsened during the decade.

Second, the age distribution of SRS is persistenly and inexplicably different from that of the censuses. These differences indicate that SRS is not fully nationally representative. Differences between national and SRS levels of crude death (and birth) rates may appear to be attributable to deficiencies in SRS (which they are, if it is supposed to function as a national representation), but they are not perfect indicators of the completeness of event recording is SRS itself. In this context it is worthwhile noting that a background paper prepared for the panel that applied SRS age-specific death rates to national (rather than SRS) age distributions, using the tests of section 2.2, found that SRS death registration is substantially better than reported in that section (Preston et al., 1979). It may be that SRS's age-specific death rates are nationally representative but that migration or sample selection problems have distorted its age distribution and biased tests of registration completeness. It should also be reiterated that the tests of registration completeness applied in section 2.2 are biased downward by the mortality decline that has occurred in India.

Whatever the explanation, we conclude that SRS crude death rates do not require correction to serve as national representations and, more tentatively, that recorded SRS child mortality levels are too high for the mid-to-late 1970s. The state-specific estimates of crude death rates that are based on adjusted SRS figures are therefore probably too high, on average, by about 1.4 per 1,000 for the decade of the 1970s.

In light of these results, it is useful to reexamine state-specific vital rates using results based on the child mortality values contained in the 1979 survey. These are not available by state, so we have used the state pattern of child mortality provided by SRS.[3] We then applied the "integrated" method to state-specific intercensal age distributions for 1971-81.[4] Birth rate estimates derived from this procedure are far more robust to the kind of errors encountered in Indian data than are death rate estimates (Preston, 1983), and we have greatest confidence in the birth rate results.

Results are shown in Table 48. They are compared to unadjusted SRS birth rates for 1971-80 and to SRS birth rate estimates for 1971-80 adjusted by the factors (based on analysis of 1970-73 experience) presented in Table 31. The correspondence between the series is quite striking. In general, 1971-81 intercensal analysis strongly confirms the level of SRS birth rates except in Bihar and West Bengal, in which SRS rates are clearly too low. Other states in which the upwardly adjusted birth rates are closer to what is indicated by intercensal analysis and in which the upward adjustment is at least 5 percent are Karnataka, Maharashtra, and Rajasthan. The north/south gradient is strikingly maintained in the new intercensal series. So is the conclusion based on Table 40 that there is little regional differentiation in patterns of fertility decline. Comparing column 1 of Table 40 (intercensal analysis for 1961-71 by state) to the 1971-81 intercensal birth rates in Table 48 shows a mean decline in CBRs of 4.9 for the five northern states, 6.8 for the five southern states, and 4.7 for other and intermediate states.

TABLE 48 1971-81 Intercensal Birth Rate Estimates by State Based on Integrated Method and Compared to SRS Crude Birth Rate Estimates: All-India

State	Crude Birth Rate Based on Intercensal Population Change	Crude Birth Rate in SRS, 1971-80	
		Unadjusted	Adjusted[a]
Andhra Pradesh	33.2	33.4	35.7
Assam	--	32.9	38.9
Bihar	39.1	31.6	--
Gujarat	36.4	37.2	39.9
Haryana	37.1	37.8	41.3
Karnataka	33.1	28.9	33.2
Kerala	28.1	27.8	29.4
Madhya Pradesh	36.4	38.3	40.3
Maharashtra	31.2	29.1	32.8
Orissa	33.2	33.3	37.1
Punjab	31.7	31.7	33.5
Rajasthan	40.9	37.3	39.1
Tamil Nadu	30.2	29.9	34.2
Uttar Pradesh	40.4	41.5	42.1
West Bengal	37.5	30.5[b]	--
State weighted			
Above states excluding Assam[c]	35.7	34.0	
Above states excluding Assam, Bihar and West Bengal	35.0	34.7	37.2
Above states excluding Bihar and West Bengal		34.7	37.2

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[a] By adjustment factors in Table 31, column 1.
[b] For 1974-80.
[c] Essentially all-India.

4.8 CONCLUSION

A final word is in order on Indian demographic statistics. The panel believes that a relatively precise picture of demographic circumstances in India has emerged in this report due mainly to the availability of overlapping sources of information. The SRS is performing a valuable service in mapping yearly trends in crude birth and death rates, yet its products would have far less value if they could not be periodically tested against other information. Particularly important in this regard are surveys asking questions on lifetime births and child deaths. It is not sufficient simply to ask about these matters; the manner in which questions are asked and the data processed are critical determinants of the quality of results, as illustrated by the comparative value of the 1972 and 1979 surveys. And providing the foundation for all attempts to understand the demography of India are the extensive series of decennial censuses, mounted at great cost in a country in which competition for resources is intense. Even though much of the 1981 census remains to be published, several pieces of evidence derived from it have been a critical ingredient in establishing the set of estimates presented here.

NOTES

1. We did not correct death rates under age 5 because they are in good agreement with the q(x) value from the 1972 Fertility Survey. We believe that deaths below age 5 are incompletely registered in the SRS but that this bias is offset to some extent by age-misstatement that transfers the lowest-mortality ages under age 5 out of that age group.
2. The intercensal growth rate is calculated from the territory excluding Assam, for which census total for 1981 was not available. For the remaining territories, the enumerated population on March 1, 1981, was 665.262 million (India, Registrar General, 1983c). The census count of April 1, 1971, for the same territory was 533.535 million. The intercensal growth rate for this territory, continuously compounded is

$$r = \ln (665.262/533.535)/9.917$$
$$= .02225$$

It is possible that the growth rate for the entire territory will differ slightly from this figure, but part of the difference will probably reflect net international migration into Assam.
3. In particular, the national q(2) estimate from the 1979 survey, when converted via the South model life

table system, implies a $_5M_0$ value (death rate for children under age 5) that is smaller by 23 percent than the corresponding value from the SRS for 1976. Thus, all state-specific values of $_5M_0$ from the SRS for 1976 were reduced by 23 percent before converting them to p(5) values using the South model system. For Bihir and West Bengal, the SRS rates were not available; in applying the integrated method, we assumed the child/adult mortality relationship in these states to be the same as in the standard life table.

4. A life table with an e_0 value of 50 years from the U.N. South Asia family was used as the standard. In every case, the line was fitted to data points for ages 5-30 and 35-55, using the grouped mean procedure.

APPENDIX A Regression Coefficients Used in Estimating Adjustment Factors k(i) When CEB/CS Data are Classified by Duration Intervals as Indicated, West Model Variant: All-India

Regression equation: $K(i) = a(i) + b(i)\frac{P(1)}{P(2)} + c(i)\frac{P(2)}{P(3)}$

Duration of Marriage	(i)	$\frac{q(x)}{D(i)}$	a(i)	b(i)	c(i)
0-5	1	q(2)/D(1)	1.2500	-0.2555	0.0195
6-9	2	q(3)/D(2)	1.1999	-0.2615	-0.0879
10-15	3	q(5)/D(3)	1.2322	0.0167	-0.3417
16-25	4	q(10)/D(4)	1.2561	-0.0542	-0.3722
26-35	5	q(20)/D(5)	1.1664	1.6023	-1.3668

Note: Based on level 12.

APPENDIX B Regression Coefficients Used in Estimating Adjustment Factors K(i) When CEB/CS Data are Classified by Age Intervals as Indicated, South Model Variant: All-India

Regression equation: $K(i) = a(i) + b(i) \frac{P(1)}{P(2)} + C(i) \frac{P(2)}{P(3)}$

Age Interval of Women	(i)	q(x) D(i)	a(i)	b(i)	c(i)
17-21	1	q(1)/D(1)	0.5047	-0.7884	0.9352
22-26	2	q(2)/D(2)	1.0143	-0.2942	0.0936
27-31	3	q(3)/D(3)	1.0835	-0.1417	-0.0657
32-36	4	q(5)/D(4)	1.0930	-0.1025	-0.0688
37-41	5	q(10)/D(5)	1.0982	-0.1002	-0.0469
42-46	6	q(15)/D(6)	1.0727	-0.0984	-0.0303

GLOSSARY

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by ${}_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol $_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by $l(x)$. The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by $e(x)$; the probability of surviving from each age x to age x + n, denoted by $_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by $_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is $1/2 \ln[p/(1 - p)]$. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x (${}_{x}q_{o}$) is related linearly to the logit of a standard probability of dying by age x (${}_{x}q_{o}^{s}$) so that

$$\text{logit } ({}_{x}q_{o}) = \alpha + \beta \, [\text{logit } ({}_{x}q_{o}^{s})],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived (${}_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, ${}_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

REFERENCES

Agarwala, B. L. (1969) Sample registration in India. *Population Studies* 23(3):379-394.

Bhat, M., and R. Kanbargi (1984) Estimating the incidence of widow and widower remarriages in India from census data. *Population Studies* (forthcoming).

Brass, W. (1975) *Methods for Estimating Fertility and Mortality from Limited and Defective Data*. Chapel Hill, N.C.: Carolina Population Center.

Brass, W., and A. J. Coale (1968) Methods of analysis and estimation. In W. Brass et al., *The Demography of Tropical Africa*. Princeton, N.J.: Princeton University Press.

Bureau of the Census (1978) *India: Country Demographic Profiles*. Washington, D.C.: U.S. Department of Commerce.

Coale, A. J., and P. Demeny (1966) *Regional Model Life Tables and Stable Populations*. Princeton, N.J.: Princeton University Press.

Coale, A. J., and P. Demeny (1967) *Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data*. Population Studies No. 42. New York: United Nations.

Coale, A. J., and E. M. Hoover (1958) *Population Growth and Economic Development in Low-Income Countries*. Princeton, N.J.: Princeton University Press.

Coale, A. J., and J. Trussell (1978) Estimating the time period to which Brass estimates apply. *Population Bulletin of the United Nations* 10:87.

Dandekar, K. (1966) Age reporting in the two recent censuses: a case study. *Indian Population Bulletin* 3:41-50.

Dandekar, K., and S. Mulay (1975) Age structures, life tables and population counts. In V. M. Dandekar and

P. Venkataramiah, eds., *Data Base of Indian Economy*, Vol. 2. Calcutta: Statistical Publishing Society.

Das, N. C., and N. Bhattacharya (1977) National Sample Surveys: an appraisal of demographic data. In A. Base, D. B. Gupta, and G. Raychandhuri, eds., *Population Statistics in India*. New Delhi: Vikas Publishing House.

Das Gupta, A., R. K. Som, M. Mazumdar, and S. N. Mitra (1955) *Couple Fertility*. National Sample Survey, No. 7. New Delhi: Department of Economic Affairs.

Dyson, T. (1979a) A Brief Note on the Official Intercensal (1961-71) Life Tables. Unpublished manuscript. London School of Hygiene and Tropical Medicine, London.

Dyson, T. (1979b) A Working Paper on Fertility and Mortality: Estimates for the States of India. Paper presented to New New Delhi Workshop of the Panel on India, Committee on Population and Demography, National Academy of Sciences, Washington, D.C.

El-Badry, M. A. (1961) Failure of enumerators to make entries of zero: errors in recording childless cases in population censuses. *Journal of the American Statistical Association* 56(296):909-924.

Ewbank, D. C. (1981) *Age Misreporting and Age-Selective Underenumeration: Patterns and Consequences for Demographic Analysis*. Committee on Population and Demography, Report No. 4. Washington, D.C.: National Academy Press.

Gani, A. V., and H. L. Kalla (1969) Results of intensive survey in Jammu and Kashmir. *Sample Registration Bulletin* 27:8-9.

Ghosh, D. (1940) The Indian fertility enquiry, 1931. In G. S. Ghurye, ed., *Indian Population Problems. Report and Proceedings of the 2nd All-India Population and 1st Family Hygiene Conference, 1938*. Bombay: Karnatak Publishing House.

Ghosh, D. (1956) The trend of the birth rate in India, 1911-50. *Population Studies* 10(1):53-68.

Horiuchi, S., and A. J. Coale (1982) A simple equation for estimating the expectation of life at old ages. *Population Studies* 36(2):317-326.

India, Cabinet Secretariat (1967) *Tables with Notes on Family Planning*. National Sample Survey, No. 116. New Delhi: Manager of Publications.

India, Central Statistical Organisation (1975a) *National Accounts Statistics, 1960-61 - 1972-73*. New Delhi: Controller of Publications.

India, Central Statistical Organisation (1975b) National Accounts Statistics, 1960-61 - 1972-73: Disaggregated Tables. New Delhi: Department of Statistics, Ministry of Planning.

India, Director General of Health Services (1959) Review of the Registration System of Births and Deaths in India. New Delhi: Manager of Publications.

India, Director General of Health Services (1972) Health Statistics of India 1965. New Delhi: Controller of Publications.

India, Director General of Health Services (1976) Health Statistics of India 1966-1970. New Delhi: Controller of Publications.

India, Kerala, Bureau of Economics and Statistics (1977) Statistics for Planning. Trivendrum: Bureau of Economics and Statistics.

India, National Sample Survey Organisation (1975) Tables with Notes on Birth and Death Rates and Fertility Rate. National Sample Survey, Report No. 206. New Delhi: Controller of Publications.

India, Registrar General (1953) Sample Verification of the 1951 Census Count. Paper No. 1. New Delhi: Manager of Publications.

India, Registrar General (1963) 1961 Census: Age Tables. Paper No. 2. New Delhi: Manager of Publications.

India, Registrar General (1964a) General Population Tables. Census of India 1961, Vol. I, Pt. II-A(i). New Delhi: Manager of Publications.

India, Registrar General (1964b) Vital Statistics of India for 1961. New Delhi: Manager of Publications.

India, Registrar General (1965) Social and Cultural Tables. Census of India 1961, Vol. 1, Pt. II-C(i). New Delhi: Manager of Publications.

India, Registrar General (1966) Vital Statistics of India for 1962. New Delhi: Manager of Publications.

India, Registrar General (1972a) Civil Registration in India: A Perspective. Census centenary monograph No. 4. New Delhi: Manager of Publications.

India, Registrar General (1972b) Sample Registration of Births and Deaths in India 1969-70. New Delhi: Manager of Publications.

India, Registrar General (1972c) Measures of Fertility and Mortality in India. SRS Analytical Series No. 2. New Delhi: Office of the Registrar General.

India, Registrar General (1973) Sample Registration Bulletin 7(1):29.

India, Registrar General (1975a) General Population Tables. Census of India 1971, Series 1, Pt. II-A(i). New Delhi: Controller of Publications.

India, Registrar General (1975b) Sample Registration Bulletin 9(4).

India, Registrar General (1976a) Social and Cultural Tables. Census of India 1971, Series 1, Part II-C(ii). New Delhi: Controller of Publications.

India, Registrar General (1976b) Fertility Differentials in India 1972. New Delhi: Office of the Registrar General.

India, Registrar General (1977a) Social and Cultural Tables. Census of India 1971, Series 1, Pt. II-C(ii). New Delhi: Controller of Publications.

India, Registrar General (1977b) Life Tables. Census of India 1971, Series 1, Paper 1 of 1977. New Delhi: Controller of Publications.

India, Registrar General (1977c) Age Tables. Census of India 1971, Series 1, Paper No. 3. New Delhi: Controller of Publications.

India, Registrar General (1977d) Sample Registration Bulletin 11(4).

India, Registrar General (1978) Vital Statistics of India 1972. New Delhi: Controller of Publications.

India, Registrar General (1980a) Survey on Infant and Child Mortality, 1979: A Preliminary Report. New Delhi: Office of the Registrar General.

India, Registrar General (1980b) Sample Registration Bulletin 14(2).

India, Registrar General (1983a) Report on Post Enumeration Check. Census of India 1981, Series 1, Paper 40 of 1982. New Delhi: Controller of Publications.

India, Registrar General (1983b) Primary Census Abstract, General Population. Census of India 1981, Series 1, Pt. II-B(i). New Delhi: Controller of Publications.

India, Registrar General (1983c) Key Population Statistics Based on 5 Percent Sample Data. Census of India 1981, Series 1, Paper 2 of 1983. New Delhi: Office of the Registrar General.

India, Reserve Bank (1978) Analysis of estimates of state domestic product. Reserve Bank of India Bulletin 32(4):276-312.

Jain, A. K., and A. L. Adlakha (1982) Preliminary estimates of fertility decline in India during the 1970s. Population and Development Review 8(3):589-606.

Kurup, R. S. (1968) Intensive enquiries in Kerala. Sample Registration Bulletin 22:12-17.

Lal, R. B., and V. S. Swamy (1976) A note on intensive inquiry in a subsample of SRS units in Andhra Pradesh (Urban). Sample Registration Bulletin 10(2):26-28.

McKeown, T., and R. G. Record (1962) Reasons for the decline of mortality in England and Wales during the nineteenth century. Population Studies 16(2):94-122.

Mehrotra, G. K. (1968) Underregistration of births in India. Artha Vijnana 10(2):213-228.

Mukherjee, B. N. (1975) Levels of fertility in Tamil Nadu based on survey statistics. In R. S. Kurup, ed., Studies on Fertility in India. Gandhigram: Gandhigram Institute of Rural Health and Family Planning.

Mukerji, S. (1982) Population scene after 1981 census. Economic and Political Weekly, July:1208-1209.

Natarajan, K. S. (1980) Child Mortality: Rural, Urban, and Sex Differentials. Paper presented to the Conference on Population Dyanamics and Rural Development, Indian Association for the Study of Population, Bombay.

Operations Research Group, Baroda (1974) Population of India: Projection, 1971-2001. Unpublished manuscript. Operations Research Group, Baroda.

Padmanabha, P. (1981) Use of Sample Registration System for Studying Levels, Trends, and Differentials in Mortality: The Indian Experience. Paper presented at the United Nations/World Health Organisation Working Group on Data Bases for Measurement of Levels, Trends, and Differentials in Mortality, Bangkok.

Preston, S. H. (1983) An integrated system for demographic estimation from two age distributions. Demography 20(2):213-226.

Preston, S. H., and N. G. Bennett (1983) A census-based method for estimating adult mortality. Population Studies 37(1):91-104.

Preston, S. H., and A. J. Coale (1982) Age structure, growth, attrition and accession: a new synthesis. Population Index 48(2):217-259.

Preston, S. H., and K. Hill (1980) Estimating the completeness of death registration. Population Studies 34(2):349-366.

Preston, S. H., N. Chen, and J. Hobcraft (1979) Preliminary Report on Application of Techniques for Estimating Death Registration Completeness of Data from the Indian Sample Registration System. Paper presented at a meeting of the India Panel, Committee on Population and Demography, National Research Council, Washington, D.C.

Preston, S. H., A. J. Coale, J. Trussell, and M. Weinstein (1980) Estimating the completeness of reporting of adult deaths in populations that are approximately stable. Population Index 46(2):179-202.

Puri, R. K. (1974) A short note on missing of vital events under sample registration in Assam. Sample Registration Bulletin 8(2-3):15-17.

Rele, J. R. (1963) Fertility differentials in India: Evidence from a rural background. The Milbank Memorial Fund Quarterly 41(2):183-199.

Saksena, D. N., and S. R. Rastogi (1975) Fertility, child mortality and family planning in rural areas of Uttar Pradesh. In R. S. Kurup, ed., Studies on Fertility in India. Gandhigram: Gandhigram Institute of Rural Health and Family Planning.

Sastry, V. V. S., and R. S. Raju (1968) An intensive survey of a district in Andhra Pradesh. Sample Registration Bulletin 22:4-6.

Saxena, G. B. (1962) Age at marriage and fertility--a sample study in the rural Uttar Pradesh. Artha Vijnana 4(1):52-59.

Shariff, A., M. Guruswamy, and A. V. Diwakar (1979) Dual record system: The vital rates estimation for the project district-1977. Newsletter (Population Centre, Bangalore) 5(4).

Srinivasan, K., P. H. Reddy, and K. N. M. Raju (1977) Changes Over a Generation in Fertility Levels and Values in Karnataka. Occasional Paper Series No. 2. Bangalore: India Population Projects.

Trussell, J. (1975) A re-estimation of the multiplying factors for the Brass technique for determining childhood survivorship rates. Population Studies 29(1):97-100.

United Nations (1961) The Mysore Population Study. Population Studies No. 34. New York: United Nations.

United Nations (1982) Model Life Tables for Developing Countries. Population Studies No. 77. New York: United Nations.

United Nations (1983) Indirect Techniques for Demographic Estimation, Manual X. New York: United Nations.

Visaria, P. (1971) Provisional population totals of the 1971 census: some questions and research issues. Economic and Political Weekly 6(29):1459-1465.

Visaria, P., and L. Visaria (1981) Indian population scene after 1981 census. *Economic and Political Weekly*. Special Number. November: 1727-1780.

World Bank (1978) *India: Occasional Papers*. World Bank Staff Working Paper No. 279. Washington, D.C.: World Bank.

Zlotnik, H. (1979) A Note on the Quality of Age Reporting in the Indian Censuses. Paper presented at a meeting of the Panel on India, Committee on Population and Demography, National Research Council, New Delhi.

Zachariah, K. C., and K. S. Seetharem (1968) Inter-state migration in India, 1951-61. *Indian Journal of Public Health* XII(1).

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